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THE

HOROLOGICAL JOURNAL:

THE

Special Organ

OF THE

BRITISH HOROLOGICAL INSTITUTE.

VOL. I 4

VOLUME II.

LONDON:

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THE

Horological Journal,

ESTABLISHED

FOR PROMOTING THE SCIENCE AND PRACTICE OF HOROLOGY.

"Those who admire and love knowledge for its own sake, ought to wish to see its elements made accessible to all." — HERSCHEL.

No. 1. SEPTEMBER, 1858. PRICE 4d.

CONTENTS.

The following are the Sections to which Communications may be presented :—

Section A. Mathematics and Physics.
B. Chemistry and Mineralogy, including their applications to Agriculture and the Arts.
C. Geology.
D. Zoology and Botany, including Physiology.
E. Geography and Ethnology.
F. Economic Science and Statistics.
G. Mechanical Science.

Notices of Communications intended to be read to the Association, accompanied by a statement whether or not the Author will be present at the Meeting, may be addressed to John Phillips, Esq., M.A., LL.D., F.R.S., Assistant General Secretary, Magdalen Bridge, Oxford ; or to the Rev. T. Hincks, W. Sykes Ward, Esq., and Thomas Wilson, Esq., Local Secretaries, Leeds.

Gentlemen desirous of attending the Meeting will find in the Reception Room blank Forms of Proposal, and may make their choice of being proposed as *Life Members*, paying Ten Pounds as a Composition, or *Annual Subscribers*, paying One Pound annually and an Admission Fee of One Pound (making together Two Pounds on admission), or *Associates for the Meeting*, paying One Pound.

Ladies may obtain Tickets, through the application of a Member, in the Reception Room, price One Pound each Ticket. These Tickets are transferable to other Ladies only.

EDWARD SABINE, *General Secretary*.
JOHN PHILLIPS, *Assistant General Secretary*.

NOTICE TO ADVERTISERS.

IN the interest of the various branches of the Chronometer, Clock, and Watch Trades, the HOROLOGICAL JOURNAL will contain space for the advertisements of those who require publicity, and a scale of charges has been resolved upon, which will unite the greatest amount of service with the utmost Economy.

Address

TO THE HOROLOGICAL PUBLIC.

In the success of every modern effort for the amelioration of mankind the Press has played so prominent a part, that it would appear simply like taking the *high road* to begin any new scheme by at once engaging its help.

But as, by its very universality, the thousand services it has to perform render it difficult to prevent one subject obscuring another, except by each speciality possessing its own vehicle, the Committee for the organization of the British Horological Institute has resolved, that a Journal devoted to the interests of this art shall be established (this being the first number), to appear monthly, of dimensions suitable for binding, and at a price that shall place it within the reach of all, and without profit; so that the greatest amount of solid information may be supplied to those who, from the apathy at present manifested in the artistic part of their profession, appear particularly to require a healthy stimulant; whilst, if this stimulant be found in the Journal, the effects will re-act upon the parent Institute, which will thus be enabled to make fresh efforts for the cultivation of taste amongst its members; in whose ranks, it is to be hoped, every man practising a trade the fruit of the science of Horology will ere long be found enrolled.

After labouring in the formation of the Institute over six months, the Committee feels the necessity for more extended means of communication with the vast body engaged in this comprehensive subject, resident both in London and the country, and feels convinced that the want will be supplied in the best possible way by a Journal.

In addition to the foregoing, an arena is absolutely required for the discussion of disputed points, whose settlement may possibly lead to a fusion of those numerous classes into which the Horological trades are at present divided—a consummation that would conduce to the advancement of the solid interests of the science.

So fascinating has the science of Horology ever been found, that nearly every man of scientific eminence has at times pursued some branch of it as an amateur; amongst some of these, inventions have arisen with which it would be well for professional men to be brought into more frequent contact, and the inventors into more intimate relation with those most capable of usefully employing their discoveries.

It is principally to the want of such a medium that the Committee attributes the very few names yet on the Donation and Subscription list of the Institute amongst the manufacturers and first-class retailers, whose education alone might lead to direct appreciation of the benefits to be derived by all classes from the cultivation of science—men who would resent as an insult the imputation that they were other than the leaders of the art. Whilst granting them such high position, their absence from

the present movement can only be attributed to a wise delay pending the proof that the art is ripe for consolidation. A Journal will soon settle that point.

Again, most men who have from time to time been brought into contact with any considerable number of Watchmakers must have noticed, that there arise continually cases of invention and improvement of processes perhaps incapable of being made lucrative, either by patent or otherwise, and which, although useful, are held back from the knowledge of those to whom such contrivances might be very valuable, because, from the want of a Record, even the honour is of doubtful security,—and all men are jealous of the honour of invention. A Journal at once supplies such a record, and will be found to prevent the formation of many a soured temper and misanthropic disposition.

In fact, the art of Horology has given rise to a class of mechanics of surpassing activity of invention (in spite of bad education), one half of the benefit of whose labours has been lost to the world from the want of that which none should lack in this country,—" a clear stage and no favour."

Judging from the amount of original invention in this country in almost every branch of the productive arts, and the number of horological wants still unsupplied, there must exist another desideratum, which a Journal may supply, — namely, an Exchange or Mart instrumental in the equalization of such supply and demand.

Finally, even without the origination of anything, there is room for its constant employment merely to utilize existing material; which material, it is hoped, holders both in London and the country will liberally supply for the good of the public.

ORIGIN AND PROGRESS OF THE BRITISH HOROLOGICAL INSTITUTE.

On the 16th of February, 1858, a number of persons engaged in the Watch Trade met together, and having formed themselves into a Preliminary Committee, decided upon issuing the following Address, which was pretty extensively circulated amongst the Trade, but which we here reprint for the benefit of those into whose hands it may not have fallen :—

"ADDRESS

" *To Watch, Clock, and Chronometer Makers, and all Parties interested in the Advancement of the Art of Horology in England.*

" If Horology is to take the high place amongst us to which, as a native art, it is entitled, then, sooner or later, must a movement be made to collect the scattered productions of those ingenious inventors and enthusiastic devotees in science whose efforts have contributed so materially to enrich the art, and render it so powerful an adjunct to the sciences of Navigation and Astronomy.

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"5. That a list be now opened for the reception of the names of those persons who intend to become Subscribers to the Institute.

"6. That Mr. J. Breese, Senior, be appointed Secretary."

A number of subscribers were added to the lists; and the meeting terminated with a cordial vote of thanks to the Chairman.

Since the above meeting the Committee have been engaged in drawing up such laws as they deem necessary for the government of the Institute, which will be submitted to the members for their consideration, at a meetin to be called for that and other business, will be seen by the advertisement in thi Journal. A copy of the laws, as recommende by the Committee, is also inserted, in orde that members may have an opportunity c considering them in relation to any alteration or amendments they may be desirous of pro posing.

The Committee have also hired premises which, although but temporary, can be use as a Library, Reading-room, and Secretary's Office.

Draft of the Laws

Recommended by the Committee of Management of The British Horological Institute, to be submitted to the Members at their General Meeting on the 6th September, 1858.

NAME OF THE INSTITUTE.

1. That this Association, which was formed on the 15th of June, 1858, be called The British Horological Institute.

OBJECTS.

2. The objects for which this Institute is founded are, to develope the science of Horology,—to foster the arts and various branches of manufacture arising out of it,—and to stimulate and encourage the production of the best workmanship, by suitable rewards and marks of distinction; and to attain these results by the formation of a library, reading-room, and a collection of tools, models, and machinery; also by the delivery of lectures, and the reading of original papers on subjects connected with the art of Horology and the various branches of trade or manufacture connected therewith.

SHALL CONSIST OF.

3. That this Institute shall consist, for six months from the date of the laws, of all persons becoming Founders, Life Members, or Annual Subscribers of Twelve Shillings: a donation of Ten guineas to constitute a Founder, and Five guineas a Life Member.

GOVERNMENT.

4. That this Institute shall be governed by a Council of Forty Members, with a President and Two Vice-Presidents The Council to be elected by the members. One-half, at the least,

of the Council to be artists or working men; the remainder to be manufacturers, retailers, and others who are or have been actually engaged in Watch or Clock making, or in one of the branches connected therewith.

The Council shall be elected annually, but all the members thereof to be eligible for re-election. The President and Vice-Presidents to be elected by the Council from Nine gentlemen chosen by the members: such selection to be by ballot. Each member of the Council to have, on this and on all other matters pertaining to discussions of Council, but one vote; and the acting President or Chairman to have the casting vote only.

HONORARY AND OTHER OFFICERS.

5. The honorary officers shall be the President, Vice-Presidents, Trustees, and Treasurer; other officers, Assistants, Auditors, and Secretary, if necessary.

MEMBERS' VOTES.

6. That all matters affecting the general interests of the Institute, except the alteration of laws or the making of new ones, shall be decided by a majority of votes at a General Meeting; and that on all questions on which members are entitled to vote, they shall each, in the first instance, be entitled to one vote only, and to one additional vote for every three consecutive years of membership, until the member has acquired three votes, which shall be the maximum. All General Meetings shall be convened by notice from the Secretary in writing; and all notices to be deemed duly served if delivered to the member personally, or left at his registered residence or posted thereto, three clear days previous to the General Meeting, unless such General Meeting be called for making alterations or amendments in or addition to the laws, in which case six days notice shall be given.

In all cases of making, altering, or amending the laws, it shall be lawful for members to send their votes in writing to the Secretary, under inclosure, which shall not be opened till the time of voting, and then only by the parties appointed to examine and register the votes. No votes in writing to be deemed valid, unless received twenty-four hours before the time of voting.

No addition to the laws, nor any alteration or amendment therein, shall be made, unless by the consent of two-thirds of all the votes of the members; and no vote shall be received from any member who is six months in arrear.

BUSINESS OF THE COUNCIL.

7. That the business of the Council shall be the management of the affairs of the Institute, in accordance with the fixed laws (made or approved by two-thirds of all the votes of members); but the Council may make bye-laws or regulations for management, which shall not be inconsistent with the general or fixed laws and the objects for which the Institute was established.

To examine original papers, and decide upon those to be read before the Members.

To decide upon what Lectures shall be delivered.

To establish Classes for instruction in all those branches of education which are necessary for the attainment of a sound theoretical and practical knowledge in the art of Horology, and its dependent branches of trade and manufacture.

To procure by all practicable means, translations of the best foreign authors on Horological art, science, or manipulation.

To select works for the Library; models, machinery, specimens of engines, tools, &c. for the Museum; and to cause the same to be properly arranged and described.

COMMUNICATIONS.

8. All communications to the Council, or on business connected with the Institute, must be addressed to the Secretary at the office of the Institute; and no communications can receive attention unless the name and address (in full) of the applicant be given.

TRUSTEES.

9. That there shall be Three Trustees elected by the members, and that all the property of the Institute (except cash) shall be vested in the Trustees for the time being, for the benefit and use of the members; and that no property so vested shall be sold, exchanged, or otherwise disposed of without the consent of the said Trustees (given in writing) and the approval of a majority of the Council; such approval to be entered upon the minutes of Council; and should any dispute arise in Council on such a matter, then the matter shall be referred to a General Meeting of the members; and no disposition of the property shall be made without the consent of three-fourths of the whole of the votes of all the members present at such meeting (of which due notice shall have been given, according to Rule 16). Also, all property, such as models, machines, tools, books, drawings, prints, sketches, or other goods or things of whatsoever kind, which shall at any time be lent to or deposited with the Institute for the use or benefit of the members, shall be the property of the Trustees for the time being, during the term of such loan; but the said Trustees shall, upon requisition duly made by the proper owner of such property, or by his or her legal aepresentative, return the same without delay. They (the said Trustees) shall also sign receipts on forms to be provided for the purpose, for all loans of property to the Institute, and receive receipts from the owner of the property upon the return of such loans.

The said Trustees shall also appoint for a specified term, from amongst the members, two or more Examiners, whose duty it shall be to examine the property belonging to the Institute, or on loan thereto; to compare the same with the Property or Stock Book periodically; and, should any loss or damage thereof have been sustained, to make an immediate report thereof to the Trustees and Council.

10. That a Property or Stock Book shall be kept, in which shall be entered a descriptive account of all the property of the Institute (except cash), stating whether the same has been purchased, presented, or lent, and which book shall always be open for reference to the Trustees, Council, and Examiners.

11. The Council shall have the power of delegating the management of the various items of business to Sub-Committees, chosen by themselves, either from their own body or from amongst the members, as to them may seem most desirable.

12. That in each country town, in which there are several members, one of them shall be appointed as "*Corresponding Member,*" who shall represent the Institute in that place, and collect donations and subscriptions in his locality; such appointment to confer the privilege of a seat (but not the power of voting) at the Council Board when in London.

13. That, in order to extend the usefulness of this Institute, and render it more efficiently available as a means of obtaining instruction by the junior members of the different trades and professions connected with the art of Horology, the sons of members under eighteen years of age, and apprentices of members, shall be admitted to all the benefits of the Institute (except the right of voting), upon payment of an annual fee of Three shillings.

TREASURER.

14. That a Treasurer shall be appointed by the members, who shall receive all cash belonging to the Institute, and keep an account thereof; all disbursements on account of the Institute shall be made by him (through the Secretary), for which his (the Treasurer's) sufficient authority shall be an order signed by two or more of the Finance Committee, which Committee shall consist of Three of the members chosen by the Council from its own body.

That all receipts for cash shall be signed by the Secretary, who shall pay all moneys he may receive (on account of the Institute) into the hands or to the account of the Treasurer within fourteen days of his receiving the same.

SECRETARY.

15. That the duties of the Secretary shall be, to attend all Meetings of the Institute, Council, and Committees, and keep minutes of such meetings; to conduct the correspondence, keep the accounts, receive donations and subscriptions, and pay the same to the Treasurer according to Rule 14, and to attend to the general business of the Institute.

GENERAL MEETINGS.

16. That, upon receipt of a requisition signed by Twenty-one members, or by Seven members of the Council, the Secretary shall convene a General Meeting of the members, the notice for which meeting shall state the purpose for which the meeting is convened; and whenever such meeting is for any alteration of any of the fixed or general laws, the proposed alteration shall be stated in the notice.

ANNUAL REPORT AND AUDITORS.

17. That in the month of June in each year the Council shall cause a Report to be made of the progress and present state of the Institute; such Report to be accompanied by a Balance Sheet prepared by the Secretary, giving a fair statement of the receipts and disbursements during the past year, together with an account of the assets and liabilities of the Institute; and that such balance sheet shall be audited and approved by two Auditors (members of the Institute, but not of the Council); and that such Report and Balance Sheet shall be printed, and each member entitled to a copy.

The Auditors shall be appointed (for the year) by a majority of the members present at the Annual Meeting, or the first General Meeting after the same.

J. BREESE, SEN., *Secretary.*

OFFICE, 19, St. John's Square.

LIBRARY NUCLEUS.

The attention of intending Donors and Friends of the Institute is respectfully directed to the following English Works, &c., of which it is desirable the Institute should be in possession.

Horological Disquisitions, by JNO. SMITH, C. M. 12mo, London, 1708.
The Artificial Clock-Maker, by W. D., F.R.S. (Derham). 12mo, London, 1714.
HARRISON's Account of the Proceedings in order to the Discovery of the Longitude at Sea, relating principally to his Timepiece, in a Letter to ——— Member of Parliament. 2nd edition, 8vo., London, 1763.
HARRISON's Narrative of the Proceedings relative to the Discovery of the Longitude at Sea by his Timekeeper, subsequent to those published in the year 1763. 8vo, London, 1765.
CUMMING's Elements of Clock and Watch Work. 4to, London, 1766.
HARRISON on the Mensuration of Time. London, 1767.
HARRISON's Remarks on a Pamphlet lately published by Dr. MASKELYNE. 8vo, London, 1767.
The Principles of Mr. HARRISON's Timekeeper, with Plates of the same on India paper, published by order of the Commissioners of Longitude. 4to, London, 1767.
HATTON on Clock and Watch Work. 8vo, London, 1773.
HARRISON on Clock Work and Music. 8vo, London, 1775.
Narrative of Facts relating to some Timekeepers constructed by THOS. MUDGE. By THOS. MUDGE, Jun. London, 1792.
MASKELYNE's Answer to a Narrative of Facts, by THOS. MUDGE, Jun. 8vo, London, 1792.
THOS. MUDGE, Jun.'s Reply to MASKELYNE's Answer to a Narrative of Facts, &c. 8vo. London, 1792.
COUNT DE BRUHL's Register of a Watch. 4to.
MUDGE's Description of his Timekeeper, to which is added a Narrative by THOS. MUDGE, Jun. (his Son). 4to, London, 1799.
PARR on Pocket Watches, London, 1804.
Captain SABINE's Account of Experiments to determine the Figure of the Earth by means of the Pendulum vibrating Seconds in different Latitudes; as well as on other Subjects of Philosophical Inquiry. 4to, London, 1825.
EARNSHAW's Appeal. 8vo, London, 1808.
REID on Clock and Watch Making. 8vo, Edinburgh, 1826; and a Reprint about 1847.
HENDERSON's Historical Treatise on Horology. 8vo, London, 1836.
Results of Experiments on the Vibration of Pendulums with different Suspending Springs, by W. J. FRODSHAM. 4to, London, 1839.
ABBOTT's Treatise on the Management of Public Clocks. 3rd edition, no date.
Time and Timekeepers, by ADAM THOMPSON. 12mo, London, 1842.
E. J. DENT on the Construction and Management of Chronometers. 8vo, London, 1842.
EIFFE's Improvements in Chronometers, and MOLYNEUX's Specification of Patent for Improvement in Chronometers. 4to, London, 1842.
VULLIAMY on Railway Clocks. 8vo, London, 1845.
B. R. & J. MOORE's Book of Designs for Clock Cases. Folio, London, 1848.
Clock and Watch making, by E. B. DENISON, M.A. 12mo, London, 1850.
Correspondence between B. L. VULLIAMY and the Commissioners of Her Majesty's Woods and Works. London, 1851.

PARLIAMENTARY PAPERS.

A Return (in obedience to an Order of the House of Lords), dated May 18, 1847, for a List of Papers relative to the Great Clock for the New Palace at Westminster. Ordered to be printed June 24, 1857.
A Return to an Order of the House of Lords, dated 31st of May, 1847, of all Specifications and Estimates sent by Mr. DENT, and by Mr. WHITEHURST, to the Office of Woods, &c., relating to the Great Clock. Ordered to be printed July 16, 1847.
Copies of Three Letters, addressed by Mr. DENT to the Commissioners of Her Majesty's Woods and Forests, on the 3rd May, the 8th June, and the 3rd July, 1847, respectively.

WHAT IS HOROLOGY?

Not a few of those into whose hands these pages may fall will be disposed to ask, "What is Horology?—what does it mean?" And, to come closer home, not a few of those who are engaged in the watch manufacture will not fail to ask, what "Horology" can have to do with them? It will be the endeavour of the promoters of this Journal to answer these questions, and to show the bearing of science upon the practical manufacture of timekeepers in general.

We may be permitted to remark, that, although it may not be generally recognised, the construction of a watch is as much an effort of intellect as the building of a steam engine. A competent knowledge of the principles of construction of the one is as much a matter of study as is an understanding of the laws of action of the other. It requires as general and as accurate an acquaintance with the ramifications of Natural Philosophy to improve the one as to perfect the other. And yet, what is the fact? Engineering is dignified as one of the "liberal" professions, and watchmaking is a mere trade! *Let us endeavour to give it a position more worthy of its importance and its merits.*

The exclusively practical man (who, we humbly submit, is to be preferred to the *mere* theorist) may not at first sight see the need of going beyond his own well-beaten circle to acquire knowledge of which he does not exactly see the object. But even such have sometimes had occasion to remark the desirableness of knowing a little more than they do, and of being thus prepared for contingencies which may and will arrive in the experience of all. To say nothing of the higher and more ennobling efforts of intellectual knowledge, it is surely desirable for all to have a good and sound reason for every process they follow and every construction they adopt.

If we look around us, do we not see that in the present state of society the man of the most cultivated mind is the one who takes the lead on all occasions? No matter what his origin, the man of intellectual industry (or clever man) will be able to hold his own, and be respected and treated with deference by those who in point of social position would otherwise look down upon him.

Can we conceive a more noble object than the endeavour to elevate our fellow-men? And ought not "Charity to begin at home?" There are among the practical followers of Horology those who by wealth and attainments have great power of action. We appeal to them to lend a hand—aye, and to do more,—to give by their energy and talent a character to a movement that is surely worthy of the best of us—namely, THE PROMOTION AND ENCOURAGEMENT OF INTELLECTUAL SUPERIORITY.

DECIMALS.

An Article for our Junior Readers.

One of the objects of a publication devoted to a particular art, trade, or manufacture, should be the improvement of the junior practitioners engaged in the several departments, and to furnish such preliminary information as may enable them to proceed, step by step, from the consideration of the first or elementary principles, and the simplest manipulations of their profession, to a perfect comprehension of its most difficult propositions, and to the practice and execution of works requiring the greatest accuracy and judgment.

In furtherance of such an object, we intend to devote space in this Journal to a series of articles particularly addressed to our junior readers; and, since every branch of the Watch Trade suffers from the want of a universal system of gauges, and as any new system, to be worth any thing, must be based upon the decimal principle, we shall commence with an article on Decimal Arithmetic. These articles will, of course, be of a general character only, as we hope to fill our pages with matter of greater interest than details which will be more effectually inculcated at one of the classes at the Horological Institute.

When it is considered, not only that almost all calculations, whether relating to the expansion of metals, the specific gravity of bodies, the relative value and proportions of different weights and measures, the lengths and oscillations of pendulums, simple or compound interest, insurances, the probable duration of life, the value of annuities, &c., &c., are based upon the decimal principle; but that all tables, whether astronomical, philosophical, commercial, or mechanical, have at least their fractional parts expressed in decimals, it will at once be evident how important a knowledge of this kind is, as a preliminary to the attainment of a sound scientific education. In fact, no scientific work can be read to advantage without it.

In introducing a subject like decimal arithmetic, we shall probably be asked, Why we introduce into a should-be scientific journal that which may be obtained from every treatise on arithmetic? In addition to the reasons

already given, we think we have a good answer in the fact, that not one in ten of those who have gone through the ordinary routine of school education, have any knowledge of the principle, or appreciation of the usefulness of decimals.

Presuming that our young readers have made ever so little progress in arithmetic, they will know something of our ordinary system of notation, or numeration, as it is generally called. They will readily understand that in any row of figures which can be written down —say, 84216 for instance—the value of each individual figure is not simply that which its name imports; thus, the figure 4 in the above example does not indicate *four*, but *four thousand*; neither does the 2 mean *two*, but *two hundred;* nor is the 1 *one*, but *ten;* in fact, the 6 is the only figure in the row which represents the number which its name indicates. This arises from the fact that the figures are affected in value by the position which they occupy in the row. The figure 6 stands in the right-hand place, which is called the place of *units* or *ones;* and the value of every other figure in the row depends upon how many places it stands to the left of the figure 6, the first place to the left being the place of *tens;* the second, that of *hundreds;* the third place from the 6, or the fourth in the row, that of *thousands;* so that the value of each figure increases tenfold at every step to the left hand, and of course diminishes in the same ratio if we begin at the left and proceed to the right hand of any row. The least observant reader will, by this time, have seen the utility of this system, or application of the law of increase in value according to position; for it enables us to express large numbers with very few figures,—a thing which could not be done without some such arrangement. Taking it for granted that the foregoing, which is simply an example of the ordinary system of notation, or numbering, is properly understood, let the reader take the same row of figures, and place a dot to the right-hand of the unit's place and after this dot (which is called the decimal point, because it serves to separate the decimal from the whole number, or units) place several other figures, thus—84216·1264. Here are four figures added to the former whole number 84216, and yet the value of that number has not been increased by so much as a single unit, or *one*. And why is this? Because the dot, or decimal point, being placed in its position merely to indicate where the units terminate, and the decimal figures commence, does not affect the law of increase to the left hand and decrease to the right, which proceeds just as though no point had been interposed. To a novice it may appear paradoxical, that four figures ·1264 should be added to a number without increasing its value by so much as *one;* but if he has read carefully, and reverts to the law already referred to, he will find, not only that it is true, but that if thousands of figures had been added to the right-hand of the decimal point, their aggregate amount would never be equal to *one*. By the law he will find that the 1 to the right of the dot is not *one*, but *one-tenth;* the 2, not two, but two-*hundredths;* the 6, six-*thousandths;* and the 4, four *ten-thousandths*. The foregoing number 84216·1264 would be read thus: Eighty-four thousand two hundred and sixteen, decimal one, two, six, four; and the decimal part would be equivalent to $\frac{1264}{10000}$ that is, twelve hundred and sixty-four ten-thousandth parts of a *unit* or *one*.

We have said that thousands of decimal figures may be added to the right-hand of a row of figures consisting of a whole number without increasing it by one; we will give another illustration of this, because upon a thorough understanding of this law of increase and decrease in the value of figures according to place, depends much of the future success of the student. Let us take the number 1, and placing the dot after it, then add a 9 (which is the greatest decimal that can be added in one figure), it thus becomes 1·9, and is read, One decimal nine, or One and nine-tenths (of another unit or one). Now this 1·9 is short of the number 2 by *one-tenth* (of a unit). Add another 9, and it becomes 1·99, one and ninety-nine hundredths, which is short of 2 by *one-hundredth* (of a unit); add a third 9, and it becomes 1·999, which is one and nine hundred and ninety-nine *thousandths*, which is still less than 2 by one-thousandth (of a unit); and, strange as it may at first appear, the reader, if he has patiently read this article, will see clearly how it is that if the operation of adding nines had been continued for a thousand years, still the result would be short of the number 2; for he must have observed that in every step of the process, however small the amount required to complete the number 2, still the addition of another 9 only furnishes nine *tenths* of that amount.

We trust that by this time our young readers, who may have known nothing of decimals before, have got a pretty distinct perception of the principle upon which a knowledge of them is fotunded, They will know that a dot, or decimal point,* between two figures denotes units on the left-hand, and

* Sometimes the decimal point is a comma, thus (,) When the dot is used, it should be placed above the line on which the figure stands thus (·), and not on the line (.) as is often done.

tenths on the right; they will remember the law of increase to the left and of decrease to the right, and will, after a very few trials, be able to tell the value of the decimal part of any number they may meet with. Should any however yet be in the dark, let them read again and again if necessary, as we feel convinced that nothing more is necessary to a thorough comprehension of the principle; which is all we intended to convey in this article. The subject will be resumed in our next, when we hope to advance those who shall have determined to proceed with the subject another step in their progress.

TO OUR READERS.

As we have had the temerity to rush into print, and the presumption to assume a title of some importance, it may be expected that we should furnish some reasons for the step we have taken. We will do this candidly and truthfully, although it may be that we do it but imperfectly; and most happy should we have been to see the work in abler and better hands. In the absence, however, of any medium of communication between the various branches of the Watch, Clock, and Chronometer Trade, or any vehicle through which their position and standing as a part (and not an inconsiderable one either) of the manufacturers of this country could be estimated by the public, we have presumed to fill a gap which no one else seemed disposed to enter.

We shall, doubtless, be expected to show, (indeed we have already been asked) how we intend to benefit the art of Watch-making? What are our plans, and what are the materials at our command, for producing a change in a long-established manufacture? How is such a thing to be done, without great power, influence, and capital?

Now, we do not hold it impossible for a single individual to regenerate a whole community, indeed the feat has been performed, and by means, to all appearance quite as inadequate to the task, as that of a Journal supported by the working Watchmakers alone (if alone they must be in this undertaking), to effect a great and beneficial change in the art —aye, and the science too—of Horology in this country.

We freely confess that we have been induced to undertake the editorial department of this Journal with a view to the promotion of the incipient Institution, an account of which forms so prominent a feature in its pages; at the same time we reserve to ourselves the right of approving or disapproving of the course of action pursued by its officers and members, and of expressing our opinions upon its laws, management, or tendencies, free from all control.

Mind can no more come in contact with mind without eliciting a spark of intellectual light, than can flint with steel without bringing forth the spark of fire; and frequently the more forcible the contact, the brighter the scintillations. Be it a part, then, of our plan, to place the materials in juxtaposition, to supply the intellectual tinder, which our correspondents may fan into a blaze, which shall purify by its light, and comfort with its warmth, every member of the Horological fraternity.

To accomplish this portion of our design, we must draw largely upon the resources of our friends and correspondents; but they must bear in mind, that contributions to the stock of general knowledge do not impoverish, but serve to increase that of the contributor.

All men who have passed through life with their eyes open must acknowledge, that more real knowledge and more experience are frequently gained by failures than by success in the various affairs of life; and this remark particularly applies to those engaged in the mechanical arts. And this fact encourages us to the adoption of another part of our plans, which will be to collect and transmit to our pages, where practicable, the authentic inventions of early practitioners in the art of Watch-making, whether they have come into general use or not; and, where possible, to give the reasons for their success or failure. Wherever it is impracticable to transmit the account *in extenso*, we shall give references to the works in which it may be found.

Descriptions of new tools, new processes, and new inventions in the art will receive immediate attention, and, if useful, a conspicuous place.

The statistics of our manufacture will be a subject upon which we hope to be the means of imparting some useful information.

We are prepared to show that well-made English watches are far better adapted to encounter the contingencies of hard wear, and when subject to it, will give a much better performance, and moreover can be made at prices, which would defeat the evils of foreign competition, without pecuniary injury to either manufacturers or workmen, provided they will only be honest to themselves and each other.

We shall conclude by expressing a hope that Watch-makers will not be behind other professions in supporting an organ of their own, and by their contributions render it worthy of the profession whose interests and improvement it shall ever be its constant aim to advance.

CLOCK AND WATCH MAKERS' ASYLUM.

The building belonging to this institution is at length complete, and, we believe, ready for occupation. We are glad to learn that an election of candidates is to take place in October next; which circumstance will, doubtless, be the means of adding considerably to the list of annual subscribers. In the achievement of any work of pure benevolence such as this, or of public utility, such as affording instruction and the means of moral elevation to the less fortunate members of society, much of the success depends upon example; and in this case the trade is much indebted to V. Knight, Esq., who was the first who placed 100 guineas at the disposal of the Committee, and to this timely stimulant we have no doubt much of the subsequent success may be attributed. The manufacturers of Clerkenwell followed this noble example; the shopkeepers likewise have not confined themselves to small donations, many of them have evinced great liberality. The result has been a building every way worthy of its intended object—namely, to provide a comfortable home for the declining years of those who, by age or infirmities (to which the watch-making business so peculiarly predisposes), are reduced to the necessity of becoming the recipients of other men's bounty.

It is to be hoped the workmen (now that they see the building which has been provided) will, one and all, contribute their penny per week (for the annual subscription of Five shillings is but a fraction more), and thus entitle themselves to a vote in the distribution of the funds of an Institution calculated to ease the aching heart of many a fellow workman, a friend, a brother, a parent, or perchance their own, when the power to labour is gone past recovery.

The life of this Journal may be but short, although we will endeavour to render it so useful as to obtain for it a permanent existence; but short or long, we will always endeavour to find room in its columns for a paragraph, or an advertisement (gratis), in promotion of the interests of the Asylum.

Correspondence.

To the Editor of the Horological Institute.

Clerkenwell, 28th August, 1858.

Mr. Editor,—Perceiving that it is in contemplation to commence a Journal to represent the Watch and Chronometer interest, as well as to help in the education of the young intended for some branch of those trades, I *take the liberty of* asking a question—namely, if it is your intention to spare a corner for the admission of questions relating to the subjects upon which you particularly treat, so that information may be obtained from Correspondents even if you should not yourself be prepared to give the answer.

I have grown grey in the trade, and can remember the earliest numbers of the first periodical professing to be in the interest of Mechanics, and Mechanical science, namely, the *Mechanic's Magazine*. I was but a lad, but I still remember with what delight I saw questions and answers upon the most rudimentary mechanical and arithmetical problems, and am not ashamed to admit, that, simple as they were, they appeared to me at the time, not only very profound, but they certainly did start many a train of thought, and caused amongst labouring men many a chat, which ended in the best results. Now, I cannot but think that the adoption of such a course will secure you a great many readers, who would otherwise fail to find sufficient to interest them. I am, &c.

Vertical.

To the Editor.

August 28, 1858.

Mr. Editor,—My master went out the other day for an excursion—for you must know we are not very busy. After dinner I went into the shop—for he did'nt take me with him—and I noticed that it was past one o'clock, and the minute hand was exactly over the hour hand. "Three-quarters of an hour to the good." So I sat down and had a snooze—"A jolly long one," says you when I tell you that I did'nt wake up till past four; and then I found the minute hand exactly over the hour hand, between four and five. Now I should like to know how long my nap lasted, for I'm bless'd if I can tell; perhaps some of your young ones, more cunning than I am, will find it out for me. Your's very humbly. Somnus.

(I think that means *sleepy*, don't it.)

NOTICES TO CORRESPONDENTS.

All Communications for this Journal, should be addressed to "The Editor,*" at the Office*, 19, Saint John's Square, Clerkenwell.

The Journal will be presented to Members of the Institute this month, but cannot be continued, until the number of annual subscribers amounts to 400, when we pledge ourselves to do so.

We have inserted the letter of Vertical, but the course recommended by him had been anticipated.

Somnus.—If you will keep wide awake, and attentively read the articles to our junior readers (but not in your master's time, mind), you will soon be able to answer such questions as your's, and much more difficult ones too.

PROGRESS OF THE BRITISH HOROLOGICAL INSTITUTE.

In our first number we devoted a considerable space to an account of the Institute—indeed, some of our readers complained (perhaps not unjustly) of the amount of this kind of matter contained in the Journal. We fear that we shall, for the first few numbers at least, be obliged to render ourselves obnoxious to the same charge. Be that as it may, we must bear it with patience. But for the Institute this Journal would not have been in existence; and until the Institute is in a position to dispense with our assistance—in fact, until it gets firmly established, we feel bound to devote to its service all the space its officers may require. Our primary object is to serve the Institute, and we promise our readers, that when that is placed in the position which it deserves to hold—which the wants of the Horological community so much require that it should occupy—and which it will be the fault of the Watchmakers if it does not attain, they shall not want matter, of a kind, and we hope of a quality, suitable to the demand. The progress of the Institute, we are pretty certain, will be slow—for it has not only to travel the level line of indifference, but to surmount a steep incline of ignorance and prejudice—prejudice, too, not of a dormant kind, but active and mischievous. We trust this will subside—that better feelings will predominate. If any thing could shake our confidence in the ultimate success of an institution so well calculated to supply an urgent necessity—a necessity admitted even by its opponents, it would be the fact that any pressure or undue influence were used to gain a single member; we believe every one of its supporters would repudiate such an interference; and we trust we shall not again hear of that system of intimidation which has made its first essay against the Institute in one of the most contemptible forms that can well be conceived. We hope, however, for the sake of the parties themselves, that reflection will point out their error, and prudence suggest another course, and that where the Institute cannot receive a conscientious support, it will not be attacked with secret and unlawful weapons. If such a course is persisted in, we have the remedy in our own hands, and shall not fail to use it.

We are happy to say that the number of the members is steadily increasing. The Reading-room is opened every evening, from seven till ten; and it only requires a few good Lectures to give an impetus which shall ensure its ultimate success.

On the 6th of September a General Meeting of the Members was held at Myddleton Hall, for the purpose of electing Trustees and other officers, and for passing the laws, &c. At this meeting, Mr. W. Hislop, Jun., F.R.A.S., was called to the chair, and briefly opened the proceedings by stating the objects of the meeting to be, the election of officers, and passing laws, &c.; for although some of the offices had been filled by election at a previous meeting, that meeting could scarcely be deemed a meeting of Members (it being in fact a public meeting, viz., that at which the Institute was formed on the 15th of June), and therefore it was thought advisable, now that a considerable number of members had enrolled their names, and were about to pass laws, that a formal and legitimate election of the whole of the officers should take place at the same time, or at least that they should be nominated at the present meeting, which should be adjourned till a future day for their election.

The draft of the Rules, or Laws, as given in our last, were then read entire, and afterwards *seriatim*, and were passed, with the exception of Rules 6, 8, 14, and 17, which also (after some amendments) were passed in the amended form.

It was then moved by Mr. Moore, seconded by Mr. Trewinnard, and carried, "That the Council, which was ultimately to consist of Forty members, should be limited to Twenty (of whom Five should form a quorum) until the Annual Meeting in June, 1859."

It was also moved by Mr. Johnson, seconded by Mr. Purser, and carried, "That the election of a President and Vice-President of the Institution should likewise be deferred till the Annual Meeting."

The nominations were then made to the various offices, and Thirty-one Gentlemen were nominated as Members of Council, the election of all of whom was deferred till September 13th, to which day the meeting was then adjourned for that purpose.

At the close of the meeting the Chairman solicited donations or loans of books, models, &c., for the use of the Institute. The Secretary also said, that he had already received several models, and that he himself would place 100 volumes at the disposal of the Council. The meeting then terminated.

On the 13th of September the members again met, and Mr. W. Hislop, Jun., was elected as Chairman.

It was then moved by Mr. Trewinnard and seconded by Mr. Brooks, "That the Trustees and Treasurer be *ex officio* Members of Council."—This was objected to by Mr. Hux, as an alteration of a Rule; but it having clearly been shown to be an omission and contrary to all precedent, it was carried by 20 against 5.

It was then proposed, that the names of all those persons nominated as Councillors who had not paid their subscriptions should be struck off the Balloting Lists; but this proposition was negatived.

Messrs. WARMAN and KIRK were then elected Scrutineers; and, on the motion of Mr: Johnson, seconded by Mr. Catherwood, it was carried, "That the ballot should close at Nine o'clock."—The balloting then proceeded; and, having closed, shortly after Nine, the Chairman announced the following Gentlemen as duly elected, viz:—

Trustees.

VALENTINE KNIGHT, Esq., 3, Cornwall-terrace, Regent's Park.
JAMES ADAMS, Esq., 21, St. John's-square.
E. J. THOMPSON, Esq., 5 & 6, Percival-street.

Treasurer.

Mr. E. D. JOHNSON, 9, Wilmington-square.

Secretary.

Mr. J. BREESE, Sen., 49, Myddleton-street.

Council.

Mr. J. S. ADAMS, 21, St. John's-square.
„ J. S. BAKER, 14, Great Sutton-street.
„ J. BENNETT, F.R.A.S, 65, Cheapside.
„ S. A. BROOKS, 52, Great Sutton-street.
„ F. CATHERWOOD, 18, Gerrard-street.
„ D. CLARKE, 8, Goswell-road.
„ W. B. CRISP, 81, St. John's-street-road.
„ W. HISLOP, Jun., F.R.A.S., 108, St. John's-street-road.
„ R. R. HUX, 10, Spencer-street.
Mr. CHAS. I. KLAFTENBERGER, 157, Regent-st
„ KULBERG, 3, Denmark Grove.
„ B. MARRIOTT, High-street, Islington.
„ H. MOORE, Islington Spa.
„ G. MYLNE, 2, Great Percy-street.
„ F. POTTER, 17, New Charles-street.
„ H. RICHARDS, 2, Charles-street, City-road.
„ J. TREWINNARD, 33, Hatton Garden.
„ J. F. WATSON, 21, St. John's-square.
„ J. C. WEBB, 53, Spencer-street.

A vote of thanks was then given to the Chairman, and the meeting closed.

Since the above meeting the Council have held two meetings, viz., one on the 22d, and one on the 29th of September. At the former, Sub-committees were appointed for management, finance, &c.; and at the second, Mr. W. HISLOP, Jun., F.R.A.S., was chosen as Chairman of the Council, and Mr. R. R. HUX as Vice-chairman, until the Annual Meeting in June, 1859; a Committee has also been appointed to frame a set of bye-laws.

As we shall shortly publish in the Journal the whole of the Laws and Bye-laws complete, we merely insert the three amended Rules in the form they will now take, together with the Resolution before alluded to, which ought to be considered as an addition to Rules 9 and 14, and will probably at some future time be embodied in them.

THE AMENDED RULES, WITH THE RESOLUTION.

MEMBERS' VOTES.

6. That all matters affecting the general interests of the Institute, except the alteration of laws or the making of new ones, shall be decided by a majority of votes at a General Meeting; and that on all questions on which members are entitled to vote, they shall each, in the first instance, be entitled to one vote only, and to one additional vote for three consecutive years of membership, when the member shall be entitled to two votes, which shall be the maximum. All General Meetings shall be convened by notice from the Secretary in writing; and all notices to be deemed duly served if delivered to the member personally, or left at his registered residence or posted thereto, three clear days previous to the General Meeting, unless such General Meeting be called for making alterations or amendments in or addition to the laws, in which case six days notice shall be given.

COMMUNICATIONS.

8. All communications on business connected with the Institute must be addressed to the Secretary at the office, accompanied by the name and address of the applicant; but all written lectures or original papers on horological or other subjects, designed for the use or instruction of the members by being read, or placed in the Library, should be addressed to the Council for approval, and may at the option of the sender have a distinguishing mark or motto only attached, accompanied by the real name under enclosure with a similar mark, which enclosure shall not be opened unless the communication be accepted and adopted.

TREASURER.

14. That a Treasurer shall be appointed by the members, who shall receive all cash belonging to the Institute, and keep an account thereof; all disbursements on account of the Institute shall be made by him (through the Secretary), for which his (the Treasurer's) sufficient authority shall be an order signed by two or more of the Finance Committee, the said Committee having first obtained the signature of the Chairman of the Council to such account, which Committee shall consist of Three of the members chosen by the Council from its own body.

That all receipts for cash shall be signed by the Secretary, who shall pay all moneys he may receive (on account of the Institute) into the hands or to the account of the Treasurer within fourteen days of his receiving the same.

ANNUAL REPORT AND AUDITORS.

17. The Annual Meeting of the Institute shall be held in the month of June in each year, at which the Council shall cause a Report to be made of the progress and then present state of the Institute; such Report to be accompanied by a Balance Sheet prepared by the Secretary, giving a fair statement of the receipts and disbursements during the past year, together with an account of the assets and liabilities of the Institute; and that such Balance Sheet shall be audited and approved by two Auditors (members of the Institute, but not of the Council); and that such Report and Balance Sheet shall be printed, and each member entitled to a copy.

That all Nominations for Officers shall be made in writing at least one month previous to the time of Election; Lists of such Nominations to be posted in the Institute, and a copy sent to each member Six clear days previous to the Election.

The Auditors for the first year to be chosen at the first General Meeting of Members which takes place.

WHAT IS HOROLOGY?

(*Continued from page* 11.)

A full and complete answer to the question "What is Horology?" could not be contained in a nutshell. It involves the consideration of the art in its origin as well as in its multitudinous ramifications. Our Journal is intended to be an answer to the question *in extenso*, by considering alike the history and practice of the art, and by tracing its origin and conditions in earlier times, as well as its gradual improvement and present condition.

The following is intended as a condensed account of the earlier modes of measuring time, and of the steps whereby the great foundation principles of the present construction of timekeepers became established.

The term *horology* is from two Greek words, signifying a *discourse* and *an hour*, or *the science of hours*.

From the term "*horologium*" having been applied by ancient writers indiscriminately to all instruments which had anything to do with hours, whether sundials, clepsydræ, or instruments for representing the motion of the heavenly bodies, like our orreries and planetaria, great difficulty is found in identifying the contrivances of which they speak.

It is said by some, that clepsydræ, or water clocks, were in use before the contrivance of sundials; but this seems to want proof. We can easily believe that, even in the most primitive conditions of society, some method of measuring time was speedily found necessary. Those who were blessed with quick observation—and, doubtless, such persons existed then as now—would very soon notice the shadows of the trees or rocks, and that such shadows moved over a certain space as the sun passed across the heavens. They would also observe that the shadow always stood at a certain point when the sun was the highest, thus dividing the day into two equal parts. It would then be easy to subdivide the space passed over by the shadow into any convenient number of spaces, and the position of such shadow in respect to those marks would indicate roughly the passing of time. The next step would be the erection of a pillar, or setting up a pole, in the most convenient position, and the marking down of something like an hour circle. It would, however, now be found, that the only position in which the shadow would point to the same place at the same time of day all through the year was, when it was placed parallel to the axis of the earth, and consequently in our hemisphere pointing

towards the north. This would alter its inclination at various places, according to the latitude, or distance from the equator. Still a perfectly upright gnomon would by its shadow indicate the precise hour of noon at certain seasons of the year.

There is some pretty good (if not absolutely positive) evidence, that the famous obelisks of the Egyptians were intended as gnomons. We know on good authority that pillars were used as such in Greece and Italy; and nothing seems more likely than that when Augustus applied to this purpose the two grand obelisks which he caused to be removed from Egypt to Rome, he merely continued the use to which they had been devoted. There is a curious quotation in Josephus, which implies that the Egyptians really did use these obelisks for the purpose indicated; which quotation has the claim of superior antiquity as an authority, referring as it does to the time of the Israelitish Exodus.

The sundial of Ahaz mentioned in the 20th chapter of the 2d Book of Kings is the first on record, and enables us to give a very early point in the history of the invention, without affording any clue to its origin. It is necessary to notice here, that the Hebrew has no word to express a *dial;* the word in the passage in question signifying *steps*, or *degrees*, the degrees or steps of Ahaz. This has led a considerable number of commentators to conclude that this famous dial was nothing else than a stair, formed with so much art and proportion that the shadows of the steps expressed the hours and course of the sun. From the manner in which it is mentioned it seems to have been considered rare and curious, since it was distinguished by the name of the King by whom it had been erected. It would appear from the fact that this king Ahaz sent from Damascus the pattern of an altar which he saw there, with directions to make one like it at Jerusalem, that he was what we should call in these days a man of taste, and a collector of curiosities. Probably this dial was one of his curiosities, and perhaps originated like the altar, being either imported from abroad or made from the pattern of one that he had seen elsewhere. The Jews were not remarkable for their inventions, and it is by no means necessary to suppose that the use of sundials originated among them. Doubtless, however, as we have already observed, they had their common and popular method of measuring time by the length and inclination of the shadows of stationary objects, which in all times and countries have served for that purpose, and which continue in use among the peasantry of some cultivated nations at the present day.

It is interesting at this point to observe, that the going back of the shadow upon the sundials is supposed to have attracted the notice of the Babylonian astronomers, and that the object of the embassy which was sent to Hezekiah was, to know the occasion of this wonder.

One of the explanations, and by no means an unlikely one, given of the construction of the dial of Ahaz by the Rabbis is, that it was a concave hemisphere, in the middle of which was a globe, the shadow of which fell upon division lines engraved on the concavity. The use of such a dial will be illustrated by the fact, that the pillar or obelisk used as a gnomon was ultimately, as an improvement, surmounted by a ball supported on a small stem, and so elevated that its shadow was thrown upon the neighbouring soil with great precision. Curiously enough, the elevated ball has been revived in our own day for marking the passage of time, not indeed by its shadow, but by its elevation and fall in connexion with one of the marvels of modern times,—the electric telegraph. The ball, however, was by no means an essential part of the concave hemispherical dials, a simple stylus being more usually employed to cast the required shadow.

It is pretty clear therefore that the first sundials, properly so called, were the invention of the Babylonians. This nation was among the earliest cultivators of astronomy, and, as well as the other nations of the East, divided the day into 60 parts. They also had a duodecimal division of the day; for Herodotus tells us, that the Greeks learned of the Babylonians to divide the day into 12 equal parts. We also learn from this statement the fact, that the western nations derived their first horological knowledge from Babylonia. From them they learned the use of two instruments,—the pole or sphere, and the gnomon; the gnomon being the sundial, and the pole or sphere being a moveable instrument, for we find one used in the famous ship of Hiero described by Athenæus.

The earliest sundial of which we have any definite description was the hemicycle, or hemisphere of the Chaldæan astronomer Berosus, who probably lived about 540 years before Christ. This was the most simple of all sundials, and thus probably preceded others. It required no mathematical theory for its construction, a distinct notion of the apparent motions of the heavenly bodies alone being sufficient.

To understand this dial, let us suppose a concave hemisphere placed horizontally in an open space with the concavity turned towards the zenith, and let a ball be suspended, or fixed in any way, at its centre. When the

sun's centre rises above the horizon, the shadow of the ball will enter the hemisphere, and throughout the day the sun's shadow will trace its path on the inside. Now, if the lines described by the shadow on the solstitial and equinoctial days be traced on the inside of the sphere, and also on as many intermediate days as convenient, and these lines be divided into twelve equal parts, lines being drawn through the points of intersection, we shall have a series of oblique lines which will divide the period between sunrise and sunset on any day of the year into twelve portions, called of old *temporary hours*.

Anaximander, who introduced the first actual dial into Greece, had travelled in Chaldæa, and thus had become acquainted with this construction. His dial marked the equinoxes and solstices, and by this means the seasons. These dials were named by the Greeks σκαφη a *boat*, and ημισφαιρον, a *hemisphere*. This class of hollow hemispherical dial is represented by *fig.* 1, drawn from one

Fig. 1.

found about 150 years ago at Ravenna, and appeared mounted on the shoulders of a Hercules. *Fig.* 2 represents a large marble sun-

Fig. 2

dial on the point of a rock on the right of the monument of Thrasyllus at Athens. Le Roy, a French antiquarian, thinks it corresponds to that which we have already described as the invention of Berosus. It is from Vitruvius that we get the particulars as to these dials of Berosus; but he is not very definite as to the actual inventor, and may possibly mean merely that Berosus first introduced the instrument to the notice of the western nations. In this case it may well have been in use before the time of Ahaz, and have become known to him when he went to meet the Assyrian king at Damascus.

Some think that *figs.* 3 and 4 best answer the description of the dials of Berosus. *Fig.* 3

Fig. 3.

is from one of white marble found at Civita in 1762, and is particularly interesting as one of the most simple and primitive of its class. The other, also of marble, was discovered in

Fig. 4.

Mount Tusculum, near Rome, in 1726, and forms the principal subject of a dissertation by Zuzzeri, an Italian antiquarian, who supposes it to have belonged to Cicero, who in one of his letters speaks of having sent an *horologium* to his villa near Tusculum. There is also a dial in the Elgin collection of the British Museum, which exhibits four different dials on as many faces of the stone, and which is conjectured to have been intended to show the hour at one of the cross ways of Athens, at which city it was found.

(*To be continued.*)

COLE'S RESILIENT ESCAPEMENT.

Sir,—In sending you a description of my improved escapement for publication, I regret not having been able to prepare a drawing and full particulars, and that I can now only state, my principal design in making the improvement was, to remedy the common liability of detached lever watches to error of acceleration on time from the casual influence of external motion on the balance.

This very desirable object is now completely effected by the time preserving pro-

perty of the principle employed, and which I may briefly explain to consist in making either the escapement wheel or the pallets of such a form as to produce a slight recoil of the wheel, by motion of the pallets, in both the locking and unlocking directions, thus giving to the lever an elastic or resilient action, which allows the ruby pin to pass, by a small displacement of the lever, instead of the ordinary abrupt banking; the lever being instantly restored to its first position by the escape wheel pressure on each pallet respectively, the balance and impulse pin returning always correctly to the former condition of simple action, after traversing more than an entire revolution from the point of rest.

In addition to the above, a simplification results from the disuse of banking-pins, and also of the guard pin and roller. The guard pin and roller may, however, be used at discretion. A further advantage is gained by the improved form of the wheel teeth and pallets, which admit of closer scaping, with perfect freedom, and an economy of power otherwise lost in drop, allowing the use of a greater weight of balance and stronger pendulum spring.

I may here mention, that all watches made by me on the Resilient Lever principle have performed in the most satisfactory manner; and, however much the weight of balance may be increased (within proper limits), the ruby pin and pivots are subject to no injury from excess of motion, as in riding, or by improperly moving the watch instead of the key in the art of winding.

This improved escapement is also less liable to disarrangement in the process of cleaning, though done by persons previously unacquainted with the principle; and, by reason of the new form of the wheel teeth, and reduced pallet angles, is found to retain the oil better, and maintain more permanently the proper extent of vibration.

I am, Sir, your obedient servant,

29, Devonshire Street, Queen Square, Bloomsbury. J. F. COLE.

P.S.—I may here mention, that the above time-preserving principle was introduced by me in the Duplex and Chronometer Escapements, of which various examples are extant in watches completed and sold from 1843 to 1849.

[We believe we shall be able to give the complete specification and plate of Mr. Cole's escapement in an early number of the Journal.—Ed.]

SHERRATT'S TIME GLOBE, OR PLANETARY CLOCK.

"It is interesting to ruminate on what is passing in various parts of the world at the same moment. While some of the inhabitants of earth are enjoying the warmth of a meridian sun, others are ploughing the trackless deep in the obscurity of midnight, some are at their morning avocations, some at their noontide meal, some enjoying the evening breeze, others renewing their strength and vigour in the repose of night, and all at the same instant of time."—*Gent.'s Mag.*, xcii, *p.* 607, (1822.)

We insert an engraving, with so much of the inventor's prospectus as is descriptive of the invention, which is now on view at the South Kensington Museum. Our friends will, doubtless, perceive in this article a modification of the principle of the Geographical Clock which, in their school-boy days, figured at the beginning of Goldsmith's Geography, and yielded so many hours of innocent and, we may add, rational amusement.

The prospectus says, "Few now are there among us who have not both friends and relations scattered over the many dependencies and colonies of their native land. To such then, and, in fact, to all who value an object of the most essentially domestic use, my *Time Globe* or *Keeper* must recommend itself; it being a Terrestrial Globe, rotating on its axis simultaneously with the pointer or hand, together making one revolution before the 24-hour clock-face in that time. Every hour is divided into twelve parts, of five minutes each,—the quarters and halves being more distinctly marked. The several portions of the day are also inscribed and coloured thereon, and the cardinal points given. In a right line with the pointer a

black meridian passes over whatever place on the globe the time may be set for,—shewing it not only there but at all other places under the same meridian. On turning a button, which projects through the circular opening of the glass cover, it will cause the white meridian, attached at the south pole of the globe, to move over any place at which the time is required to be known; and the index fixed thereto, on passing before the hour circle on the clock-face, will shew the time at that and all other places under such meridian."

The inventor anticipates that from their cheapness and utility, combined with the astronomical and geographical advantages which they possess, these Time Globes will do much to encourage thought and stimulate inquiry.

THE TRADE IN FINERY.

(*From* The Statesman *of September* 18, 1858.)

Englishmen do not excel in the manufacture of finery. They can make the substantial necessaries of life as well as anybody, but finery, such as lace, silk, jewellery, and all matters of mere ornament and semi-utility, seem to be uncongenial to the Englishman's capacity for work. In everything that requires muscle and nerve, Englishmen beat all competitors, but they do not take kindly to finery.

Since the settlement of the Corn-law question nobody has asked for protection but the workers in articles of ornament or luxury. Sometimes Nottingham has faintingly, and full of doubt, asked for protection to its lace, but the demand has been so slight that the nation has not even heard it. Nottingham adopted a much better course than asking to be helped—it helped itself; it took to inventing new processes and making new descriptions of articles. It has thus been enabled to hold its own; but, with all its energy and perseverance, it is continually trembling on the verge of defeat by its French rivals. It has maintained its position only by its mechanical progress.

Spitalfields has no doubt about its claim to protection, which it has been constantly demanding, in one shape or other, for thirty or forty years. Indeed, so narrow are the views of the London silk-workers that they have some of them gone so far as to demand protection against their own countrymen. They have made no effort to help themselves. They have stuck to old processes while their fellow-workers in the eastern, western, and northern counties have been progressing. In fact, if the silk-trade had depended upon London enterprise, the probability is that at this moment we should not have had a single silk loom in this country, whereas the trade employs but little short of three quarters of a million of people. But, like the lace-trade, it is continually on the point of surrendering to the French.

Clerkenwell formerly demanded protection as lustily as even Spitalfields, but its voice has completely died away in the distance. We never hear a whisper from that birthplace of watches and jewellery now about protection. It has suffered materially by the superiority of French and Swiss productions, but it seems to have discovered that there is no way out of its difficulties but such a way as it can find for itself. The watchmakers are now making an energetic effort to improve their art. They have established a Horological Institute, and, as a means of intercommunication amongst its members, a *Horological Journal* has been issued. The first number of this paper is now before us, and the least that can be said of it is, that it is got up in a highly creditable manner. The greater portion is occupied with the prospectus of the Institute—a document which indicates that the promoters have thoroughly comprehended the importance of their project. The objects are stated to be—"To develope the science of Horology; to foster the arts and various branches of manufacture arising out of it; and to stimulate and encourage the production of the best workmanship by suitable rewards and marks of distinction, and to attain these results by the formation of a library, reading room, and a collection of tools, models, and machinery; also by the delivery of lectures and the reading of original papers on subjects connected with the art of Horology." With these objects in view, a spirited and energetic directory will be able to do more for the watch-trade, not only in Clerkenwell, but throughout England, than can be accomplished by any system of protection, even though amounting to prohibition.

In the three trades mentioned—silk, lace, and jewellery—the main object should be to produce articles adapted to the purposes of the great body of the people. There is but little chance of obtaining customers amongst the upper classes, who take but a very small number of very high-priced articles. The truth is, whatever ultra-democrats may say to the contrary, the great bulk of the wealth in this country is in the hands of the middle and working classes, who will always be the best customers, not only for the primary necessaries of life, but for those conveniences which our advancing civilization is daily bringing more and more within the category of necessaries. Some of our manufacturers

of finery have thoroughly understood this, and benefited by their knowledge. The greatest firm of silk manufacturers in England have accumulated their enormous wealth by ministering to the wants of the multitude —by bringing silk within the reach of almost the poorest amongst us. The same thing has occurred in the lace trade. Nottingham has been supported for many years past by the purchasers of cheap net and lace. The hundreds of patents taken out by Nottingham inventors have all been directed towards cheapening production, and not to the enhancement of luxury and expense. These trades have only been able to hold their own against foreigners by producing "common things." Coventry has endeavoured to do the same thing in the watch trade, but less successfully; its productions having too much the "Brummagem" character,—cheap, showy, and useless. Let Clerkenwell, in its new Institute, set itself the task of showing that cheapness and utility are compatible, and it will find an enormous market amongst the 30,000,000 people in these islands, the greater part of whom have never yet been patrons of horology.

Repudiating altogether the idea of protection, as tending to inferiority of production, we are far from going the length of the *laissez faire* free-traders. The schools of design in all our great centres of trade for the production of fancy textile fabrics, are examples of the manner in which Government may properly aid manufacturers in their competition with foreigners; but even these are contrary to the doctrines of the Cobden and Bright school of political economy. A wise and patriotic statesman will endeavour to stimulate the industry and invention of his countrymen, more particularly in those trades that are in danger of being superseded by foreign production. The trades that are threatened most from that quarter are such as depend least upon iron and coal for their various operations, and the most important of them, so far as numbers are concerned, are watch-making and silk-weaving. The effort now making by the watchmakers is just such a one as has a fair claim upon Government for support, upon the principle laid down by Lord Derby in relation to the new Galway harbour, that those who try to aid themselves are the fittest recipients of the State bounty. Two or three hundred pounds per annum, in the shape of prizes for the best (and cheapest) productions of Clerkenwell would be a powerful stimulus to the trade. It has formed the organization through which such prizes could most fitly be distributed; and if a guarantee of good management can be given, there is reason to believe that Government will receive such a proposition favourably. Clerkenwell has made the first working men's movement for the preservation of their trade, by the only rational means—improved processes. Spitalfields, which is in precisely the same commercial position as Clerkenwell, ought pomptly to follow.

THE AMERICAN WATCH MANUFACTORY,

AT WALTHAM, MASSACHUSETTS.

(*From* Leslie's Illustrated News, *a New York Paper, of August* 21, 1858.)

This manufactory stands on the banks of Charles River, in the town of Waltham, Mass., and occupies a site of surpassing beauty, the enterprise having been removed from Roxbury, where it was first started in 1849–50, and made permanent where it now stands.

The manufactory occupies an area of one hundred by one hundred feet, and forms a quadrangle, with an open court in the centre.

The building is two stories in height, and has eight hundred feet of floor line, with about sixteen hundred feet of bench line for the accommodation of the workmen.

The motive power is a twelve-horse steam engine, which gives motion to lines of shafting in all the rooms, to which are attached the numerous ingenious, delicate, and wonderful machines which are used in the various processes for transforming the crude materials into the exquisitely finished parts of the watch, the completest result of human ingenuity and skill yet attained.

The original projectors, after a number of years of trial and experiment, became involved financially, and the enterprise in 1857 fell into the hands of Messrs. Appleton, Tracy and Co., the present enterprising proprietors, who have made arrangements to extend their operations, and to continue the manufacture on a scalé commensurate with its importance, and in accordance with the enlarged views of the originator, Mr. A. L. Dennison, who still continues to occupy a high position in the establishment, to the organization of which he has given years of thoughtful care and intelligent skill.

Appleton, Tracy and Co. have added about one hundred acres, forming an admirable and delightful location for home sites for their workmen, several of whom have already purchased lots and erected comfortable homes in the immediate vicinity of the manufactory, and every facility is afforded to encourage

and attract the attention of intelligent and skilful workmen; who are here afforded largely remunerative and constant employment under the most pleasant conditions, with an opportunity in a few years of securing a competency and an independent home in the midst of scenery and surroundings as beautiful and interesting as can be found anywhere in the Swiss cantons, at Locle or La Chaux de Fonds; at Prescot or Coventry, in Lancashire or Warwickshire in England; with other advantages and attractions such as are nowhere else to be found.

The plan of manufacture is highly philosophical, comprehensive, complete and peculiarly American, resembling that which Eli Whitney first applied so successfully to the manufacture of fire-arms, and which has been since most thoroughly tested and demonstrated at the Springfield U. S. Armoury; by Col. Colt, at Hartford; at Enfield, in England; and which has been more lately introduced at Bridgeport, Ct., in the manufacture of sewing machines. It extends to every part of the watch, commencing with the rolled plates of brass, steel and silver, the wires used for pinions, pins, and screws, and the gems for jewels; and by punching, swaging, cutting, turning, polishing, burnishing, drilling, enameling, gilding, &c., brings out the perfect living mechanism. All is done by machinery, each machine doing its peculiar work to a gauge or pattern, with an exactness that no skill of handicraft can rival. With the exception of the jewels and the pivots that run in them, every watch is in every part exactly like every other, so that a thousand might be taken to pieces and then reconstructed with pieces taken indiscriminately. As to the jewels, after they are drilled with a diamond, and opened out with diamond dust on a soft iron wire, resembling a hair in size, their perforations must have certain microscopic differences; so the pivots of steel that are to run for ever in these jewels without wearing out in the least, after being turned to a certain size, must be exquisitely polished, and by this last operation their size is reduced a little more or less. These jewels and pivots, after being thus finished, are put into the hands of a female operative, who, by means of a gauge, consisting of slightly converging lines so delicately graduated as to detect the difference of the ten thousandth part of an inch, first classifies the pivots. Then, by means of the pivots, she classifies the jewels. Jewels and pivots of the same number exactly fit. But for each pivot of a particular watch a jewel is selected with a hole that is a degree, or a ten thousandth part of an *inch, larger,* so that there may be sufficient play or side shake.

The sizes of the several pivots and jewels in each watch are carefully recorded under its number, so that if any one of either should fail in any part of the world, by writing to Waltham, or to Robbins & Appleton, general agents, 15, Maiden lane, New York, and giving the number of the watch, the part desired may be replaced, so as to be a working match. All the other parts are made precisely the same, and every dial-plate and case will fit one watch as well as another. The escapements, which in all foreign and hand-made watches have each its own individuality, are here alike, even to the escapement jewels, which are set in pallets, these being cut to a microscopic identity and rigid truth of form. It must be obvious to any one that such a system, directed by Yankee skill and ingenuity, must very nearly approach perfection, and greatly excel handicraft production.

No one who examines the machines employed in this manufactory, and attends to the attenuated details of the system, will doubt that the work of the best European watchmakers must be equalled, if not distanced, at half the cost of production. In the American watches nothing is left to the eye or touch of the workman. On every part the machine impresses its own precision. The human care is employed merely to see that the machine is properly fed. Gauges, as already mentioned, nice enough to appreciate the ten thousandth part of an inch, tell when the work is done. Not one of the nearly one hundred male and female artisans who combine to make the watch need be a watchmaker.

The simplest form of lever movement has been adopted, and three styles have been produced, varying in finish, arrangement of jewels, and other conditions only affecting the cost of production, all being equally reliable timekeepers. Arrangements are now being made to furnish a small and elegantly-finished watch for ladies' wear.

It is intended to furnish from time to time, as the wants of the trade may require, other styles and sizes of watches, including an entirely new form of "sporting" or "timing" watch, which will indicate the minutest divisions of time with more accuracy than has ever before been attained.

The advantages of the American watch to dealers and wearers will be understood by the following enumeration, namely, it has fewer parts, unvarying uniformity; the ease with which it may be repaired, and a part broken or lost by accident may be restored; its greater durability, and the great reduction

on the wholesale cost; to which is added a certificate of warranty for ten years, signed by the manufacturers. They are eminently adapted for railroad engineers and conductors, where exact and unfailing timekeepers are of the utmost importance, and where the continuous jar of the moving train offers the severest test to try the qualities of a watch. Several of the most eminent engineers and conductors on the leading railroads in the country have been supplied with these watches, and will now have no other.

In many parts of the country great difficulty is experienced in finding good watch repairers, and reliable timekeepers. By the introduction of the American watch this difficulty may be almost entirely obviated, so that the country merchant can regularly obtain watches as a part of his miscellaneous stock, and the buyer will take his regulated time-keeper, wind it up, and go about his business, as he would in buying any other article, without mystery or humbug.

We subjoin the following extract from the report of the judges in the department of watches, clocks and chronometers of the Massachusetts Mechanic Charitable Association, at its eighth exhibition, as to the merits of the American watch:

"The particulars in which they excel are such as uniformity of end-shake, perfect perpendicularity of the parts, correct depthings, good adjustment of the escapement, fitting of screws, and that substantiality by which, as watchmakers say, "the watch goes together twice alike;" or in other words, all parts find their place and keep it, and act well together, after being taken apart as well as before. Every watchmaker well knows how deficient the better classes, even of English watches, are in these particulars. The value of these excellencies will be understood when it is said that the deficiency of them is what gives the most trouble to the repairer, and both trouble and expense to the owner. It should be remarked that the superiority of the American watches in these respects results not mainly, if at all, from superior skill, but from the principles and methods employed in the manufacture, which circumstance affords a guarantee that this superiority will be maintained."

There is no article in common use about which so much ignorance prevails, and around which so much sham, charlatanism, and swindling may be and is continually practised, as attaches to the watch; and it must be gratifying to all concerned, that the day for all sorts of "watch-stuffing" is likely very soon to pass away.

These watches are already furnished at half the price of the English lever watch, and can be manufactured at the rate of twenty thousand per annum with present means.

[After every deduction on account of the imaginative, of which the preceding article contains no small amount, there is doubtless enough of fact to induce English Watchmakers to bestir themselves.—Ed.]

HARTNUP'S COMPOUND BALANCE.

To the Editor of the Horological Journal.

Sir,—Allow me to address a few congratulatory words to you on your exertions in promoting a Horological Institute and Journal, and to wish you every success in the undertaking. I have no doubt that you will meet with many obstacles at the commencement, and not the least from an unfortunate jealousy which appears to exist among the leading watchmakers, and which I hope the Horological Institute and Journal will be the means of gradually abolishing. I beg leave to say with all deference (and I only say it in my anxiety to promote the prosperity of the undertaking), that it would have been as well to have obtained the cooperation of some of the leading watchmakers, or retailers as you term them, many of whom are manufacturers as well as retailers, have practically worked at the board, and possess a superior knowledge of the theory of the art of horology. We English are of a sluggish nature, and, it cannot be denied, are prone to hesitate in entering on any new project unless with a full conviction of its ultimate success; but I have not the least doubt that if you persevere in your endeavours, you will obtain the assistance of the leading members of the Trade. The undertaking is, I apprehend, but little known out of Clerkenwell, for the first intimation I had of it was from a critical review in the Mechanics' Magazine.

I hope that the working Clock and Watchmakers will not fail to avail themselves of the opportunity of addressing the Journal on any topic, however remotely connected with the art of horology, on which they may require information, and I am sure it will elicit a ready reply from those competent to give it.

Now, to make a beginning:—I beg to call the attention of Chronometer makers to the fact, that Mr. Hartnup, of the Liverpool Observatory, in 1849, invented a compound balance, possessing (*theoretically*) the grand desideratum we have so long been anxious to acquire—viz. a means by which the weights would approach the centre, for equal variations of temperature, much faster than they would recede from it. It appears to have been very little known until last year, when a chronometer of Hornby's fitted with it stood first on the Greenwich list. Now it would be very advantageous to those who are anxious for improvements in horology,

* We believe that every effort which could consistently be made was made by the original promoters of the Institute to induce the leading members of the Trade not merely to assist in the formation, but to take the foremost places and lead in a movement in which all would have rejoiced to see them in their natural position.

and might also prevent much individual loss of time, if those who have tried this balance would publish in your Journal the results of their experience.

We have Journals and Societies devoted to Astronomy, Engineering, Medicine, Architecture, Geography, Geology, Meteorology, Photography, *cum multis aliis*, in which individual investigators publish the results of their respective sciences; and I am sure that nothing would have a more beneficial effect on the art of horology than for all engaged in it to sink the petty jealousies at which I have before hinted, and unite with a hearty good-will in endeavouring to mature the Horological Institute and Journal.

I am, Sir, your obedient Servant,

CORNHILL.

[We should be glad to receive a description with drawing, of Hartnup's Compound Balance.—ED.]

ON ELECTRO-GILDING FOR WATCHES, &c.

Although the more elegant, economical, and healthy nature of electro-gilding has caused it completely to supersede the old mercurial process, it is still open to an objection of the utmost importance—namely, inferiority in hardness and durability, to an extent only known to practical watchmakers.

It is well-known that pure gold is of too soft a nature for the manufacture of any article subject to friction, even of cleaning; and it is well-known also that a variety of alloys is necessary for various purposes, the best for wear being that of eighteen parts out of twenty-four of pure gold, known as "Standard of 18 carats." Now pure gold only is laid by the electro process upon watchwork as an ornament, and for the protection of parts from oxydation; and this will not bear even the handling necessary to complete the machine, without serious detriment. It is true, by depositing slowly a little better work is produced than that which is more hurried by the employment of too high battery power; still the best of it that I have ever seen is much inferior to the capital surface observable on old watches. "Smee" speaks of a state of deposited gold in what he calls the "reguline state;" but I cannot conceive a metal, the only method of hardening which is by compression, to be deposited from solution, even if solid, in other than the utmost degree of softness.

By the old mercurial process, in which an amalgam was formed of gold and mercury, the brass was first brushed over with a solution of mercury in nitric acid, which attacked the surface and enabled the workman to spread the aforesaid amalgam very thinly and evenly over the work, and the gold remaining attached to the surface after the evaporation of the mercury by heat not only appeared to have soaked as it were into the brass some depth, but was itself much more resembling an alloy than pure gold,—such was its hardness, and so well would it bear friction; indeed, I have always held the opinion, that the gold was really alloyed with part of the brass of the work by the very act of gilding.

In the early days of electro-gilding, the Swiss produced a very beautiful surface of a fine orange-coloured gold, by depositing silver previous to the gold. But this was still worse; for in addition to the softness and thinness of the gold coating, its even partial removal exposed the white silver beneath, which contrasted very badly; so they have had to abandon it, although an equally beautiful matted appearance has never since been achieved.

For the production of a better surface, and for the avoidance of the very improper preliminary heating and quenching in dilute acid to which the electro-gilders have recourse, to the manifest destruction of the work, I tried some time back to produce the necessary *mat* by depositing a foundation of pure copper, and am inclined to the belief that somewhere in that direction will be discovered the improvement I suggest as so desirable, especially if the ultimate coating of gold can be made to mingle intimately with the copper. Now modern electro-metallurgists have announced the possibility of depositing compound metals by the electro process; and I should like to suggest to persons in the habit of experimenting and who possess the necessary manipulative skill, the advisability of ascertaining the possibility or impossibility of effecting an improvement in this process; for its achievement would confer a solid benefit on the art, and be a cause of rejoicing amongst a body of men who have long grieved over the decadence of the quality of this branch of their profession.

I enclose my card, and shall be happy to afford any help in my power to any one who may desire information on the subject, such as may naturally be supposed part of the knowledge of A MANUFACTURER.

Correspondence.

To the Editor of the HOROLOGICAL JOURNAL.

SIR,—"Forewarned is forearmed." It is said that grumbling is the peculiar privilege

of Englishmen; but privilege or no privilege, the Clockmaking portion of the community indulged in it to such an extent at the close of the Great Exhibition of 1851 as to obtain the temporary cognomen of the "discontented Clockmakers." Now, on the principle of letting buried grievances sleep in peace, I am not inclined to re-open the controversies of that period, nor to re-awaken jealousies that had better remain unexcited. Seeing, however, that the Society of Arts has taken the initiative in a future Grand Exhibition, I think it would be well if some preparation were made by the Horological Trades, for sustaining and insuring the reputation of the working sections of this important art, and for the due recognition of merit; so that, whatever the place occupied by those in the lists of honour, all concerned might feel that justice had been secured, even if the sentence had only secured modesty.

The Council of the Horological Institute would (I beg to suggest) do well to afford to any gentlemen desirous of meeting for such an object the use of a Committee-room, and any other facilities; as it would appear to pertain to the very functions it has undertaken to perform, to aid in any such arrangement. I am, Sir, &c.

Clerkenwell. GNOMON.

[We perfectly agree with our correspondent's suggestion, and think there is but little doubt of the co-operation of the Council for such an object.—Ed.]

ANSWER TO SOMNUS'S QUERY.

Mr. Editor,—I beg to hand you a solution of Somnus's query, and hope you will like it none the worse for the employment of a few figures, at which I am not remarkably expert. The interval between the recurrence of the conjunction of the hands on a clock dial will serve to determine the period of Somnus's nap.

The motion of both hands is equable, and the hands coincide eleven times in twelve hours, therefore they do so each successive time one-eleventh of twelve hours more advanced than the last past. Now the eleventh of twelve hours is one hour, five minutes, twenty-seven seconds, and three elevenths of a second. Somnus slept during three of these coincidences, therefore his nap lasted three elevenths of twelve hours, namely,

$$(1^{h.}\ 5^{m.}\ 27\tfrac{3}{11}^{s.} \times 3) = 3^{h.}\ 16^{m}\ 21\tfrac{9}{11}^{s.}$$

I am, Sir, your's respectfully,

Clerkenwell. VERTICAL.

' Cornhill's answer was correct, but one step in the proof was omitted.

EQUATION OF TIME TABLE,

For October, 1858.

We insert the following Table of the Equation of Time, true to the second place of the decimals of seconds; with the differences for one hour. In our next and subsequent numbers, we shall add the *mean* right ascension and declination of half a dozen of the principal fixed stars, which we presume will be particularly acceptable to those who use a meridian line, or make their own observations by means of a transit instrument.

Day of the Week.	Day of Mnth	At Apparent Noon — Equation of Time, to be *subtracted* from Apparent Time.	Difference for One Hour.	At Mean Noon. — Equation of Time, to be *added* to Mean Time.
		m s.	[illegible]	m. s.
Fri. ..	1	10 18·40	0·789	10 18·53
Sat. ..	2	10 37·33	0·775	10 37·46
Sun. ..	3	10 55·94	0·761	10 56·08
Mon...	4	11 14·20	0·746	11 14·34
Tues..	5	11 32·10	0·731	11 32·24
Wed ..	6	11 49·64	0·714	11 49·78
Thurs.	7	12 6·77	0·697	12 6·91
Fri. ..	[illegible]	12 23·50	0·679	12 23·64
Sat. ..	9	12 39·79	0·660	12 39·93
Sun. ..	10	12 55·64	0·641	12 55·78
Mon...	11	13 11·04	0·622	13 11·18
Tues..	12	13 25 96	0·601	13 26·09
Wed ..	13	13 40·39	0·580	13 40·52
Thurs.	14	13 54·31	0·558	13 54·44
Fri. ..	15	14 7·71	0·536	14 7·84
Sat. ..	16	14 20·57	0·512	14 20·69
Sun. ..	17	14 32·87	0·488	14 32·98
Mon...	18	14 44·59	0·463	14 44·70
Tues..	19	14 55·71	0·438	14 55·82
Wed ..	20	15 6·22	0·411	15 6·32
Thurs.	21	15 16·09	0·384	15 16·18
Fri. ..	22	15 25·31	0·356	15 25·40
Sat. ..	23	15 33·85	0·327	15 33·93
Sun. ..	24	15 41·69	0·298	15 41·77
Mon...	25	15 48·82	0·268	15 48·89
Tues..	26	15 55·24	0·236	15 55·30
Wed...	27	16 0·90	0·204	16 0·95
Thurs.	28	16 5·79	0·172	16 5·84
Fri. ..	29	16 9·91	0·139	16 9·95
Sat. ..	30	16 13·25	0·106	16 13·28
Sun. ..	31	16 15·79	0·073	16 15·81

NOTICES TO CORRESPONDENTS.

All Communications for this Journal should be addressed to "The Editor," at the Office, 19, Saint John's Square, Clerkenwell.

We shall be happy to receive the promised papers from Vertical; but his communication (containing the promise) is unavoidably postponed till our next number.

We have received a letter from Somnus, which we are sorry we cannot insert—partly on account of its length, and partly from other causes.

Decimals. No. 2. is postponed for want of space.

BRITISH HOROLOGICAL INSTITUTE.

Last month we had to regret a species of intimidation which had been exercised against one of the members of the Institute: this month we have to rejoice in a little opposition, of that character which, from its want of argument, distortion of facts, and evident vindictiveness of feeling, is sure to do more good than harm. We are pleased to find, wherever we go, that a large amount of sympathy exists in favour of the Institute, both in and out of the circle of the Trades to which it more immediately has reference. Every intelligent, well-disposed, and unprejudiced person sees the vast amount of good which there is a probability of effecting, and expresses astonishment that those who could most materially assist in such a cause should hold themselves aloof. Our advice is, not to wait for assistance, but to begin to do the real work of an Institute yourselves—that is, the Council and the Members, for without the latter the former can do little. It is true, the former have launched the vessel and commenced the rigging her, but it is the Members by whom she must be manned, and sailed too, if the voyage is to be a successful one. The desired haven is a distant one; but there is an open sea, plenty of friendly sails in sight, who will ever be ready to fire a shot, in case of necessity, at the pirates who may hover around. But the crew must work—and hard too—for the tackle is all new, and not easily manageable, and the hands as yet inexperienced. To be plain: the Members must work in this matter; their money is not the only element of success; they must use their personal exertions. They must remember that the present number of members—about 150—has been obtained by about twenty individuals; but let each member only induce one friend to join, and the Institute will be beyond the risk of failure. But that is not all: they must do,—they must attend the reading-room (where they will always find some of the Council), and shew by their presence, and the interest they take in the cause, that they believe the Institute capable of producing a great good. To resume the figure with which we commenced—they must learn to know their pilots, and to judge of their capacity or incapacity; and, if they are worthy, to shew their confidence, and assist by their hints and suggestions the best course to be pursued. The keen glance and sturdy arm of many a British sailor has saved his vessel. We would particularly desire to see a *conversazione* of the members, or rather a regular periodical meeting; the regular attendance at the reading-room would soon put such a thing in operation. There are parties who would deliver short lectures or addresses on subjects connected with the art and science intended to be promoted. We know something of the elements necessary to success in the establishment of an Institute; and if we may be allowed to put it in the form of an advertisement, we would say, Meet, meet, meet!—and we pledge ourselves you will be successful.

A great deal has been said about the introduction of Females, and the Factory system. Now we will ask, Do you believe the Institute has been established for the purpose of introducing any such system; if you do, you are egregiously mistaken. For ourselves, we repudiate any such idea. Do the anonymous writers who have asserted it believe in it themselves; we answer without fear of contradiction, they do not Does its warmest advocate believe in it? or is it a trick of trade? We have our opinion, and we believe it coincides with that of the best-informed and most respectable belonging to the class of Workmen. We believe that this ghost of a Factory system is nothing more than a bugbear, made use of by certain half-educated, artful, and selfish men, to frighten the young in their art from seeking after that information which, if acquired, would place the aspirants after knowledge in a condition far superior to that of these noisy (if unintentional) advocates of the very system they profess to fear and condemn. To return to the Institute:—Do let us impress upon you, the members, to attend the reading-room; that is your grand field of action. It is there you must lay your plans to fight the battle of ignorance and prejudice. Remember, the stake is great, and worth fighting for. The Clock trade is gone; the Watch trade is assailed by no contemptible enemy. British energy and skill want but the addition of British good-will, to place you in a proud position in an art which had its birth in the land of your fathers, and has received its greatest improvements from their hands.

In proof of sympathy towards the Institute, as a movement in the right direction, we may refer to the annexed letter from the Clerk of the Clockmakers' Company (which we understand has been duly acknowledged), and we have no doubt that much valuable information may be the result of this kind and liberal offer. The Editor of this Journal has also received two handsome volumes, besides an Abridgement of the Specifications of all Patents relating to Watches and Clocks since 1661 to the present time, from the Great Seal's Patent Office, as a present to the Institute. A portion of the latter work is transmitted to our columns this month, and will be continued till the whole is given, which will form a most valuable collection.

CLOCK-MAKERS' COMPANY AND THE HOROLOGICAL INSTITUTE.

The following courteous Letter has been received from the Clerk of the above Company, and has been cordially responded to by the Council of the Institute:—

"CLOCK-MAKERS' COMPANY,
"6, Cowper's Court, October 12, 1858.

"SIR,—I have the pleasure herewith to hand you a Catalogue of this Company's Library, and to annex a Copy of a Resolution passed yesterday at a Quarterly Court. I am, Sir, yours very obediently,
"Mr. BREESE, "S. ELLIOTT ATKINS.
"*Secretary Horological Institute.*"

"RESOLVED,—That the HOROLOGICAL INSTITUTE, by its Secretary, be allowed the use of any Book in the Library of the Clock-Makers' Company, or any Specimen in their Collection, for any period not exceeding three months, and upon the understanding that it is not to be taken from the Meeting-room of the Institute."

"*Extracted from the Minutes, October* 12, 1858. "S. ELLIOTT ATKINS, *Clerk to the Company.*"

WHAT IS HOROLOGY?

(*Continued from page* 19.)

THE EARLIER SUNDIALS, AND THE PRINCIPLES OF DIALLING.

Martini, speaking of a dial found in 1762 at Pompeii, says, that it was made for the latitude of Memphis, and may therefore be the work of Egyptians, if not constructed in the schools of Alexandria. It may, indeed, be supposed that every nation that cultivated astronomy found it necessary to use some means of dividing and measuring time. It appears that the Egyptians had found in the heavens some means of attaining this object, but no sundial has been found among the antiquities of that country, and their sculptures give us no indication of any having existed.

There is a very curious dial, of which several examples have been found, and which seems to have been used both by the Greeks and Romans. There are no means of determining its antiquity, but it is clear that it could not, in the form which it usually bears, that of a ham (see *fig.* 5), have been known to the Jews, who hated the hog and all that belonged to it. The principle of its construction, however, was applicable to other forms, as portable instruments. It may be described simply as a ham, the tail of which served for the gnomon, and which was furnished with a hook or ring at the extremity for the purpose of suspension.

The dial is delineated on the back of the ham, on which are described six vertical lines, under which are abbreviated the names of the twelve months, beginning with January, retrograding to June, and again returning to December. Six horizontal lines traverse the vertical ones, and by their intersection show the extension of the shadow thrown by the gnomon on the sun's entering each sign of the zodiac, and consequently at every point of his path through the ecliptic. This also points out the hours of the day, the shadow descending with the rising and again ascending with the setting sun, the square compartments being marked with the hours. It seems, that when it was in use it was suspended by the hook or ring, the side being presented to the sun, and that when the extremity of the shadow of the gnomon reached the extremity of the line marked with the name of the actual month, the horizontal intersection showed the hour. There are several points of obscurity as to details, which could probably only be cleared up by the inventor. This dial was found at Herculaneum in 1754, and a similar one was found at Portici in 1755.

The first sundial erected at Rome was in the year 290 B.C.; Papirius Cursor had taken it from the Samnites. In 261 B.C. Valerius Massala placed in the Forum a dial which he had taken at Catania, the latitude of which is 5 degrees less than that of Rome; and in 164 B.C. Marcus Philippius caused the first dial to be constructed at Rome.

It appears that sundials had been common in the days of Plautus, in a fragment of one

of whose comedies, as preserved by Aulus Gellius, he makes a parasite declaim against sundials something in the following style :—

"The Gods confound the man who first found out
How to distinguish hours! Confound them, too,
Who in this place set up a sundial,
To cut and hack my days so wretchedly
Into small portions! When I was a boy,
My belly was my sundial; one more sure,
Truer and more exact than any of them.
This dial told me when 'twas proper time
To go to dinner—(when I had ought to eat);
But now-a-days, why—(even when I have)—
I can't fall to unless the sun give leave.
The Town's so full of these confounded dials,
The greatest part of its inhabitants,
Shrunk up with hunger, creep along the streets."

Dialling, or the science of gnomonics, has in more modern times been the subject of many treatises, and formed not long since an important feature in the mathematical course at our Universities. The invention of more accurate instruments for reading the indications of the heavenly bodies has now, however rendered it obsolete; but, as a matter of interest, it is desirable to indicate its elementary principles.

The theory of dialling, to be thoroughly understood, requires an acquaintance with some of the more simple doctrines of astronomy, and also of the elements of geometry, with plane and spherical trigonometry; but a less extensive knowledge will be sufficient for comprehending the construction of the more simple and common dials. A correct notion of the nature of an angle, of the method of drawing parallels and perpendiculars, how to make an angle of any required number of degrees, and also how to measure an angle, will suffice for their mere geometrical construction. The instruments required are compasses, a scale of chords or a protractor, and a straight-edged rule.

The apparent diurnal motion of the starry heavens is perfectly uniform; but the unequal angular motion of the sun in the ecliptic renders necessary a correction, called the *equation of time*, which must be applied to the time indicated by the sun. Atmospheric refraction might likewise be taken into account, but in practice it is neglected.

From the great distance of the sun from the earth all the phenomena of the solar motions, as seen from any part of the earth's surface, will be almost exactly the same as if they were seen from its centre, the difference being absolutely inappreciable. Hence, if we were to take a skeleton sphere, formed of 12 equal wire circles, or 24 semicircles, which all pass through the extremities of their common diameter, just as the meridians do in the common terrestrial globe, then if the axis be placed parallel to the earth's axis, the shadow projected by the axis will fall on the wires one after another at intervals of an hour, because the apparent angular motion of the sun about the axis will be uniform, just as it is about the imaginary axis of the earth. This simple instrument then, if correctly made, and placed in a fixed position, with its axis parallel to that of the earth would serve to divide the day into 24 equal portions.

There is one practical inconvenience here; it is, that although the precise time when the shadow of the axis passes over the wire may be noticed, yet between the hours, that is, between the circles, the shadow not being seen, the time cannot be ascertained. To remedy this, we may introduce a plain surface within the sphere, passing through its centre. It will be evident now, that the shadow of the axis will fall upon the plain surface, and be seen there at all times when the sun is visible. Lines may be drawn from each circle to the centre, which will be hour lines, and may be numbered accordingly.

This plane may be put in any inclination within the sphere. In the horizontal position just described it forms what is called an *horizontal* dial. If placed vertically, the sun will only fall on its south side, and it then forms a *south* dial, the lines being drawn as before from the circles to the centre. If placed perpendicular to the axis, it would then be in the same plane with the equator, and would form an *equinoctial* dial. In this case the wire circles being equidistant would intersect the plane at equal distances, and the shadow would move like the hands of a clock. The north side would be illuminated in the summer, and the south side in the winter. In no other position of the sphere, however, would the hour lines be equidistant, the ratio varying with the angle.

Now it is clear, that having once marked, in any position of the horizontal plane, the points where the circles cut it and have thus formed the hour lines, the circles are no longer necessary, the dial may be removed from the sphere; and when placed in a similar position with respect to the earth's axis, and the place of the axis of the sphere supplied with a gnomon, it will form a perfect sundial, and will indicate the time accordingly.

The distances of the hour lines for any angle of position may also be determined by the terestrial globe, or by the ordinary scale of chords. If we place the axis of a globe parallel to the axis of the earth, or, which is the same thing, at the same angle with the artificial horizon, it will be evident that this wooden horizon replaces our plane, and the meridian circles on the globe represent the

wire circles. If then we notice the number of degrees between the points at which these meridians cut the horizon, and lay their distances down on the circumference of a circle inscribed upon a plane, we shall also get the position of the hour circles for a sun dial. Thus, placing the meridian of London beneath the brazen meridian of the globe, we have the position corresponding to 12 hours or noon. The first meridian on either side corresponding respectively to 11 and 1, will cut the horizon at $11\frac{2}{3}$ degrees; the second, at $24\frac{1}{4}$; the third, at $38\frac{1}{2}$; the fourth, $53\frac{1}{2}$; and so on.

These proportions may also be ascertained by an ordinary scale of chords, or a sector; but this method may be more properly described in a paper bearing on the relation between mathematics and horology. It may however be desirable, for the sake of completeness, to show the method of laying down the hour distances on a sundial. We take as an example the horizontal form:—

The first point is, to draw two lines, parallel to each other, at a distance equal to the thickness of the gnomon which is to cast the shadow (see *fig.* 6). Next, draw a line at

Fig. 6.

right angles to these, the extremities of which will indicate respectively the hours of 6 in the morning and 6 in the evening. Then, with *a* and *b* as centres, draw quadrants of circles, and divide each into 90 degrees. Lay a rule over *b*, and draw the first line through $11\frac{2}{3}$, the second through $24\frac{1}{4}$, third $38\frac{1}{2}$, fourth $53\frac{1}{2}$, and fifth $71\frac{1}{15}$. Proceed the same with the other side. Extend the afternoon hour lines of 4 and 5 across the dial, and these will form the morning hours, while 8 and 7 of the morning hours prolonged will give the same evening hours.

To form the style or gnomon, draw a line *through that degree* of the quadrant which is *the latitude of the place—in this case* $51\frac{1}{2}$°. This will show the elevation of the style, which is here shown as if lying on the surface of the dial. The thickness of the style must be equal to the distance between *a* and *b*, Place the style truly upright on the dial, and it is finished.

A *horizontal* dial made for a certain latitude will be a *south* dial for a latitude which is the complement of the first, or what it wants of 90°. That is, this dial made for our own latitude of $51\frac{1}{2}$° would have to be placed in a vertical position facing the south in latitude $38\frac{1}{2}$°.

There have been a great number of different constructions of sundials, which it would be here quite unnecessary to describe; the foregoing being considered sufficient to give an indication of the principles involved in their construction. In our next we shall have to deal with *clepsydræ*, or water clocks.

⁂ By an oversight of the Printer's, the block for fig. 2, in last month's Journal, was inverted, and the error was not discovered till too late for alteration.

COMPENSATION BALANCE,

By John Hartnup, Esq.

Director of the Liverpool Observatory.

The following is from a pamphlet in our possession (purporting to be extracted from the "Monthly Notices of the Royal Astronomical Society for June, 1849,") printed by G. Barclay, Castle-street, Leicester-square, 1849.

After stating the purposes for which the Liverpool Observatory was established, the conclusions drawn from a careful inspection of the records kept and observations made on chronometers under different temperatures, and the practices adopted at the Observatory, the author continues—

"I had many discussions with Mr. Shepherd, and made several trials, from which I concluded,—

"1st. That the balance-rim must be of a circular form, so that the laminæ of brass and steel might be turned down to the requisite proportions with facility, and that the compensation and poising might be easily effected, as in the ordinarybalance.

"2d. That the balance must be so contrived that the compensating rim and weights should move towards the centre with an accelerating velocity in an increasing temperature, while in a decreasing temperature they must recede from the centre with a gradually diminishing velocity.

THE AMERICAN WATCH FACTORY.

Mr. Editor, — In any other publication than the *Horological Journal* I should have supposed that the account of the Factory at Waltham, Massachusetts, to have been one of those alarming statements occasionally put forth for trade purposes of the Puff School, intended to create a panic, to be taken advantage of in some way or other, as I doubt not this account was originally; but, standing where the copy does, it must be looked upon as admonitory, and deserves attention for the principles mentioned, whether they really are reduced to practice or not.

I have not seen a watch such as therein described, which is the only proof I would allow of value in the arrangement or execution, but I have seen a *National* watch from America, and confess I could discover nothing very alarming for English watchmakers in any part of it, especially as it was to a great extent merely a rough and tasteless agglomeration of parts manufactured *in England*, apparently got up for the purpose of turning national vanity to account; and I should be sorry to see Englishmen drawn by any such *ruse* to abandon the vantage ground time has granted to them, for I am confident that the genius that originated and gradually brought to its present perfection the art of chronometry may be excused from copying every sample of trash that roughly measures time.

As for the principles to which I alluded, the adoption of standard gauges is appreciated by all skilled workmen, and has been desiderated in England for years past, but has been hitherto postponed by the too free exercise of the "right of private judgment;" but as the Horological Institute has promised a thorough digest and reduction of principles in this matter to practice, I presume the subject may be left in the hands of those concerned. There can be no doubt that the production of the machine may be simplified to a great extent by the adoption of a limited number of sizes, and the employment of the going barrel form (which I predicate is the only one employed in the Factory mentioned); but this, with the lever form of movement, will leave the machine, however pretty, with but an indifferent character for that which should be the *sine quâ non* in all, viz., the faculty of keeping time.

Let therefore Brother Jonathan go ahead, and create by any means that please him a continually increasing demand for good watches, and I feel confident that it will still be England from which a large part of the corresponding supply will flow.

The movement lately inaugurated, and which this Journal aids, is in the very direction to insure the keeping of British skill and ingenuity up to the mark demanded by extending civilization.

One who Admires Good Work.

WATCH & CLOCK-MAKING TRADE IN SAVOY.

The following paragraph, which has been going the round of the papers, is worth the attentive consideration of our readers:—

"Watchmaking. — A report of Baron Jacquemond, senator of Sardinia, on the recent National Exhibition of Turin, contains the following on the Watch and Clock-making Trade in Savoy:—

"This branch of business was first introduced into Savoy about two hundred years ago, and about the end of the last century it had acquired considerable developement. From 1810 to 1815, the number of workmen engaged in the trade was about 1800. They established themselves in the midst of the mountains of Fauchigny, within a circuit of four or five leagues round Cluses. They were principally engaged in making certain parts of the works of common watches, the markets for which were Geneva, Switzerland, and Germany. The value of the work turned out each year is estimated at 1,800,000f. The immense progress made in Switzerland in this branch of business so much injured the trade in Savoy, that in 1844 the number of workmen had decreased to 656. In that year the town of Cluses was almost completely destroyed by fire, and the inhabitants were thrown into the greatest distress. In order to afford some relief, and to secure the future welfare of the communes in which the watch and clock-making trade was carried on, the Government decided upon founding a theoretical and practical school for that branch of business at the expense of the state. The Minister of the Interior charged the Count Pillet-will, minister for Savoy at Paris, to procure a Professor for the school, and M. Benoit, whose reputation stood very high in that business, was selected. Since 1848, the period at which the school was founded, the clock and watch-making business has, owing to his able management, completely rallied, and extended itself in a remarkable manner. Pupils in great numbers soon frequented the workshops of the establishment, and now the number of men working there amounts to about 2000, and the business has extended to other communes. Since 1848, also, the manufacture of other parts of watches, such as scapements, wheels, &c., which had not before been made in the country, has been carried on to a great extent. In consequence of the great advantages derived from this royal school, different communal workshops (which are, as it were, branches of the principal establishment) have been formed. The annual produce of this business in Savoy may now be estimated at 1,800,000f. It is of the more importance, that almost the whole of that amount is for manual labour, the cost of the raw material being very

trifling. These works are exported to Geneva, to other towns of Switzerland, and to Besançon, either directly by the workmen themselves, or through the intervention of agents. It is expected that in a short time the business will be extended to making the watches in a complete state, and thus add still more to the profits of the working classes."—*Standard.*

BRITISH ASSOCIATION.

At the Meeting of the British Association at Leeds the following papers were read :—

" ON THE COMBUSTIBILITY AND OTHER PROPERTIES OF THE RARER METALS.

" DR. A. MATTHIESSEN, F.C.S , submitted a very interesting paper, read by Dr. Odling. It embraced a description of the very beautiful metals obtained from the alkalies and alkaline earths, and was illustrated by the exhibition of a variety of these metals, as attractive as unusual. The specimens of sodium, lithium, potassium, calcium, strontium, &c., were regarded with great interest, and their combustion in an intensely brilliant white light, elicited frequent expressions of admiration. Their extreme lightness was dwelt on, lithium being lighter than any liquid and possessing little more than half the specific gravity of water. From magnesium the combustion resulted in an ash hollow throughout.

" Sir JOHN HERSCHEL observed that in this inquiry they appeared to be entering on a new creation, the results produced being no longer matters of curiosity, but involving consequences of high utility.

" The reading of the paper was followed by an exhibition by Mr. R. REYNOLDS, F.C.S., of " The practical application of Aluminium." Mr. Reynolds presented for the examination of the section a spoon and fork manufactured by Messrs. Coulson and Co., of Sheffield. The spoon closely resembled silver in colour. having, however, perhaps a faint tinge of blue. It could be produced at about half the cost of silver. The weight was only 2½ times that of water, and one-third that of silver. The sensation of handling so light a metal was a very singular one. On the Continent the manufacture of aluminium is pretty general, brooches, studs, &c., being made of it in consequence of its offering, with an alloy of copper, a very close resemblance to gold, in all but the property of weight. Mr. Coulson had stated that with 5 to 10 per cent. of aluminium he could obtain any shade of gold.—In reply to Sir J. Herschel, Mr. Reynolds said that it resisted the action of sulphur.

" ON THE EXPANSION OF METALS, ALLOYS, AND SALTS.

" Mr. F. CRACE CALVERT, F.C.S., read a paper on the results of experiments made by Mr. G. Lowe and himself on the expansion of metals and other bodies by heat. Messrs. Calvert and R. Johnson having purified a considerable number of metals for the purpose of ascertaining some of their properties, were desirous of testing their expansion and contraction when exposed to certain temperatures. The apparatus employed in making these experiments is one constructed by Mr. G. C. Lowe. It consists of a lever with a long and a short arm. The short arm is brought to bear upon the bar to be tested, and in the end of the long arm the object-glass of a telescope is inserted. An eye-piece of considerable magnifying power is so fixed that an observer, by looking through it at a graduated scale, is able to determine with the greatest accuracy the distances through which the object-glass is displaced when heat is applied to the bar. The parts of the apparatus are so adjusted that one fifty-thousandth part of an inch expansion is represented by a definite portion of the graduated scale. In the course of these experiments it was found that marked differences were observed between the results obtained and those of previous experimenters. This was attributed to the circumstance of the metals they were employing being in a pure state, and this view was confirmed by trying in the same manner metals of ordinary commercial quality. They observed also that a change of the molecular condition of a bar produced a considerable change in its ratio of expansion. Thus a bar of steel, when tempered to an extreme hardness, has a ratio of expansion fully one-third greater than when it is left soft from the fire, and most of the metals have a very different ratio according as they are cast or forged. This is particularly remarkable in the case of pure zinc, a bar of which, when well hammered, expands very little more than half the amount that it expands when cast vertically. Again, the axis of crystalization has a considerable influence upon the expansion of bodies. A bar of pure zinc cast horizontally expands much less than if cast vertically. A similar phenomenon was observed also in examining other crystalline bodies. Thus amongst the carbonates of lime, statuary marble was observed to expand more than some of the metals, amongst which are cast iron, antimony, and platinum, whilst the expansion of chalk, in which the particles are differently arranged, is little more than one-fourth that of marble. In several alloys of metals a remarkable difference was observed

between the expansion found by experiment and that calculated from by the ratios of the metals of which they were composed. Four different alloys were made and examined, and in each the expansion observed was less than that deduced by calculation from their equivalents. In alloys of copper with tin it was found that where only a small quantity of tin entered into the composition of a bar, the expansion fell considerably below that of pure copper, although the tin thus added has a much higher ratio of expansion than copper.*

"Mr. Calvert illustrated his valuable paper by tables, amongst which, as exceedingly useful to our readers engaged in manufactures, we give the following:—

Co-efficient of Expansion from 0 deg. to 100 deg.

Cadmium.........	0·003323	Copper (hamm'd	0·001769
Lead......	0·003005	Gold (do)	0·001374
Tin	0·002717	Bismuth (do.)	0·001341
Aluminium	0·002218	Iron (forged) ...	0·001187
Zinc (hammered	0·002193	Cast Iron.........	0·001117
Silver (cast)......	0·001991	Steel (hard)......	0·001402
Brass (do.)	0·001930	Steel (soft)	0·001038
Copper (do.) ...	0·001879	Antimony (cast)	0·000985
Brass (hammered	0·001828	Platinum (forg'd	0·000881

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIME-KEEPERS.

Under the above head we purpose to present our readers with abstracts of all the specifications in existence of patents relating to the above subjects. We shall continue the article in successive numbers until we have brought up the subject to the present time.

1661, February 8.—No. 131.

WORCESTER, EDWARD, Marquess of.—1. "To make a watch or clocke without string, or chaine, or any other kind of winding vpp but what of necessity must follow if the owner or keeper of the said watch or clocke will know the houre of day or night, and yett if he lay it aside severall dayes and weeks without looking or medling with it, it shall goe very well, and as justly as most watches that ever were made."

2. Relates to guns and pistols.
3. Relates to carriages.
4. Relates to boats.

(Extract from the Signet Bill, dated 15th November, A.D. 1661.

[No Specification enrolled. See Register of Arts and Sciences, vol. iii, p. 237; and Stuart's Anecdotes of Steam-engines, vol. i, p. 41.]

[1664, March 3.—No. 143.

HILL, ABRAHAM.—1. Relates to carriages.
2. Relates to guns and pistols.
3. Relates to breaking and dressing hemp and flax, and watering linen.
4. "A new way of makeing of watches and clocks to be vsed at sea for exact measuring of tyme, towardes the finding the longitude and knowing the true course and place of a shipp, differenced from all other sorte of watches by having, instead of a ballance, a rodd of wyer, or a thynn narrow plate, with a weight at the lower end thereof, called a pendulum, and at the vpper end an arme with twoe catches or holes to moue it, and certaine crooked places or cheekes for regulating the motion thereof, which motion is produced by one or more springs or weights, the said watches being fitted with balls and socketts to hang by for goeing steadily at sea."

[No Specification enrolled. Letters Patent printed, price 4*d.*]

1693, March 3.—No. 315.

HADLEY, JOHN.—1. Giving motion to machines and carriages, &c.

2. "A contrivance of measuring time a more compendious way, with one wheele only, which will goe much more exact than movements with multiplicity of wheeles, which will be of very great vse and advantage both by sea and land."

[No Specification enrolled. Letters Patent printed, 3*d.*]

RATES OF CHRONOMETERS ON TRIAL,

FOR PURCHASE BY THE BOARD OF ADMIRALTY,

At the Royal Observatory, Greenwich.

1858.

[*The following* NOTES *apply to all the three Tables.*]

(*) During these weeks the Chronometers were exposed to the external air outside a North window.

(†) During these weeks the Chronometers were placed in the chamber of a stove heated by gas.

The rate given by the first five days of trial is in every case omitted, excepting for Lawson 1304, where the rate for two days only is omitted; J. Muirhead 2310, where the rate for four days only is omitted; and Holl 101 and 103, for both of which the rate for one day only is omitted.

The order of arrangement of the Chronometers in these tables is determined solely by consideration of their irregularities of rate, as expressed in the columns "Difference between the Greatest and Least," and "Greatest Difference between one Week and the next," without reference to the duration of the trial; the position of J. French 7005 is not therefore necessarily correct.

The Chronometers J. French 7005 and J. French $\frac{1}{2}\frac{8}{1}$ were withdrawn by the maker on account of their unsatisfactory performance, the former on May 10, and the latter on April 19.

The Chronometers Holl 101 and Holl 103 were deposited for trial on May 21.

BIOGRAPHICAL MEMOIR OF

JOHN HARRISON,

INVENTOR OF IMPROVEMENTS IN TIMEKEEPERS FOR ASCERTAINING THE LONGITUDE AT SEA.

As we are about to give the "Principles of Harrison's Timekeeper," we have thought that a short account of his life would be interesting to our readers. Harrison made the first grand move towards the discovery of the longitude at sea by means of timekeepers, and deserves the lasting gratitude of his species.

John Harrison was born at Faulby, near Pontefract, in Yorkshire, in the year 1693. He was the son of a carpenter, which business he followed for several years of his life. In 1700 the family removed to Barrow in Lincolnshire. At a very early age Harrison shewed a great predilection for mechanical pursuits, and particularly directed his attention to the improvement of clocks.

After numerous failures, and a variety of minor improvements, he at length succeeded in constructing a pendulum in which the effects of heat and cold in lengthening or shortening the pendulum were neutralized by the application of the principle of the different expansibilities of different metals, which is one of those improvements that may be said to mark an era in the art of horology. For the adaptation of the same principle to the balances of watches we are indebted to Thos. Earnshaw, an improved form of whose balance by Mr. Hartnup appears in our present number.

In the year 1714 an act was passed offering a reward of £10,000, £15,000, or £20,000 respectively for a method of finding the longitude at sea within 60, 40, or 30 miles.

Harrison continued plodding on in the country, repairing watches and clocks, and making a variety of experiments, till his forty-second year, when in 1735 he came up to London with a timepiece he had invented and constructed. Here he was fortunate in meeting with men high in the profession of horology as well as astronomy, who gave him a hearty welcome, and, sinking all trade or professional jealousy, readily gave him certificates of the excellence of his timekeeper. To the honour of Halley, Graham, and others be it remembered, that through their certificates he was allowed, in 1736, to proceed with it to Lisbon in a King's ship, and was enabled to correct the reckoning to within 1° 30′. On this result the Commissioners under the act gave him £500, to enable him to proceed with his improvements. After the construction of two other timepieces, he at length made a third, which he considered so perfect as to entitle him to a claim of having it tried, and the Commissioners in consequence, in the year 1761, sent his son William in a King's ship to Jamaica. On arriving at Port Royal, the timekeeper was found to be in error only 5·1 seconds, and on his return to Portsmouth in 1762 the error was only $1^m\,54 \cdot 5^s$. This being sufficiently correct to determine the longitude within 18 miles, Harrison claimed the reward; but he did not yet get it,—so careful are economical Governments of the public money when real merit is to be rewarded. Another voyage was made to Barbadoes and some further trials, after which an Act was passed in 1765, three years after he had earned his reward, which awarded Harrison £20,000, one half to be paid on his explaining the principles of the construction of his timekeeper, and the other half as soon as it was ascertained that the instrument could be made by others. Still the payment was delayed, and it was not till 1767, after many delays and some disputes, that he received the whole of the £20,000.

Next in importance to the application of the principle of the different expansibilities of metals for counteracting the effect of different temperatures, we may place that of the *going fusee*, by means of which the watch is kept going during the time of its being wound up.

Harrison died, at his house in Red-Lion-square, in 1776. He is said to have been rather uncouth in his phraseology. On mechanics and mechanical science he could converse with clearness, but found considerable difficulty in committing his sentiments to writing, as appears from his "Description concerning such Mechanism as will afford a nice or true Mensuration of Time."

In the last volume of the *Biographia Britannica* there is a memoir of Harrison, from materials furnished by himself.

THE PRINCIPLES OF MR. HARRISON'S TIME-KEEPER.

With Plates of the same.

[*As originally published by Order of the Commissioners of Longitude, 1767.*]

PREFACE.

THE original drawings, from which these plates were engraved, together with the written paper annexed, intituled PRINCIPLES OF MR. HARRISON'S TIME-KEEPER, were delivered to the Commissioners appointed by act of parliament for the discovery of the

longitude at sea, by Mr. John Harrison and Mr. William Harrison his son, upon oath, as containing a full explanation of the principles upon which Mr. John Harrison's watch or time-keeper for finding the longitude at sea is constructed.

Mr. Harrison and his son gave also, upon oath, to the Reverend John Mitchell, the Reverend William Ludlam, and Mr. John Bird, gentlemen well-skilled in mechanics, and Mr. Thomas Mudge, Mr. Larcum Kendal, and Mr. William Matthews, watch-makers, by appointment of the Board of Longitude, and myself, such further explanation of the construction of the said watch, by word of mouth and experimental exhibitions, as we required; producing the watch, taking it to pieces in our presence, and answering to such questions as we proposed relative thereto. Some notes taken by myself on this occasion I have subjoined hereto.

The original drawings of the watch were delivered to me at the Board of Longitude, which I have since caused to be carefully engraved, under my own eyes, at the Royal Observatory, and think I can answer, that the lines on the copper-plates every where correspond with the measure of the drawings within one, or at most two breadths of the lines, which are so very fine. Nevertheless, the reader must not expect to find the impressions taken off upon common paper agree so nearly either with the originals or with themselves, owing to the shrinking of the paper after the water has been pressed out of it in going through the press. But, for the sake of the curious, and particularly artists who may be desirous to construct other watches after the model of Mr. Harrison's, I have caused a few impressions of the plates to be taken off upon India paper; which, if it be only made a little damp, by being put for a few minutes between two wet sheets of paper, will receive the impression from the plates perfect, and will not shrink at all in the drying.

It may not be improper to take notice here of a difference in the position of the pallets in the 8th and 9th figures, plates VI. and VII. which might otherwise puzzle the inspector, or, at least, induce him to think there was some error made in engraving the plates from the original.

In figure 8th, the centre of the curve of the pallets lies in the circumference of the dotted circle, whose radius is two fifths of the radius of the circle described by the edge of the pallets; but, in figure 9th, the centre of the pallets lies just without the circumference of the little black circle representing the spindle, whose radius is one fourth of the radius of the circle described by the edge of the pallets. The latter figure shews Mr. Harrison's former design, which he has since altered, as is represented in the 8th figure.

Notes taken at the Discovery of Mr. Harrison's Time-Keeper.

The balance naturally vibrates largest arcs when in a horizontal position; next greatest, when the hours XII and VI are uppermost, and the watch is in a vertical position; least, when the hours III and IX are uppermost.

Large arcs are naturally performed in less time than small ones. This Mr. Harrison inferred, because the watch, before any correction was applied, went slower in a vertical position than in the horizontal one, and the vibrations are visibly larger in the latter case.

The watch is adjusted to vibrate great and small arcs in equal times, in the following manner:

To go the same when placed vertically with the hours III, VI, IX, XII upwards successively, by making the weight of the balance different in different parts—To go the same when placed horizontal as when vertical, by the joint effect of the back of the pallets and the cycloid-pin.

The curve of the back of the pallets is an arch of a circle, whose centre lies in the line joining the edges of the pallets and the centre of the spindle, the distance of the two centres being two fifths, and the radius of the curve of the pallets three fifths of the radius of the circle described by the edge of the pallets.

The action of the cycloid-pin, when it touches the balance-spring, tends to quicken its vibrations; and the spring, leaving the pin for a longer time in the large vibrations than in the small ones, is less accelerated by it in the former than in the latter case; and, consequently, the action of the pin tends to reduce the time of the different vibrations nearer to equality. The cycloid-pin was not applied to the watch till after it came back from the voyage to Jamaica.

If the balance-spring is too strong, it must be made weaker by rubbing it away a little; but if it be too weak, it must be changed for a stronger.

The balance-spring is fastened at the outer end to a stud, which takes off the plate with a screw, and is put on again with the same screw, and steady-pins, exactly in the same position as before, without undoing the fastening of the spring to the stud at the end.

There is no adjustment for mean time, as in common watches; there was once, but it did not answer.

As soon as the watch is put together, Mr. Harrison says, it will shew its rate of going in three hours accurately the same which it will keep afterwards; so that he can soon determine it by comparison with his pendulum clock.

The balance-spring, when at rest, touches the cycloid-pin, and does not begin to leave it till the balance has vibrated an arch of forty-five degrees beyond the point of rest, while the spring is in the state of coiling itself up.

The thermometer kirb is composed of two thin plates of brass and steel rivetted together in several places, which, by the greater expansion of brass than steel by heat, and contraction by cold, becomes convex on the brass side in hot weather, and convex on the steel side in cold weather; whence, one end being fixed, the other end obtains a motion corresponding with the changes of heat and cold, and the two pins at this end, between which the balance-spring passes, and which it touches alternately as the spring bends and unbends itself, will shorten or lengthen the spring, as the changes of heat and cold would otherwise require to be done by the hand, in the manner used for regulating a common watch.

Mr. Harrison requires cold weather for adjusting the thermometer kirb, and he places the watch near a fire, with a common thermometer by it, to try if it keeps the same time as in the cold air. If not, he alters or adjusts the thermometer kirb till it goes the same in these two different degrees of temperature of the air.

The thermometer klrb takes heat sooner than the balance-spring, and he thence concludes that brass takes heat sooner than steel, and that the brass rods of a gridiron pendulum should be made thicker than the steel ones.

Whilst the heat is increasing, the watch will sometimes go one tenth of a second slower in three hours, than when the heat is come to a stand.

The effect of the thermometer is increased by rubbing the sides thinner, and is lessened by thickening the edge by burnishing it.

Mr. Harrison adjusts the thermometer kirb first, that is to say, before he adjusts the watch to go the same in different positions.

The watch may be put with figure XII turned each day alternately different ways, for fear one part of the box in which it is kept may be hotter than the other.

The force or momentum of the balance, Mr. Harrison says, is as the square of its diameter, also as the square of the velocity, its weight being given.

The momentum of the balance acquired by *increasing the velocity is* better than that acquired by increasing the weight; as friction is not thereby increased, perhaps, if anything, diminished, and the resistance of the air only is increased, the effect of which is tolerably uniform, and of great service.

The diameter of the balance is 2·2 inches, of the plate 3·8 inches.

The balance should be a little larger, or 2¼ inches, according to a memorandum taken by Mr. Bird.

The watch makes just five beats in a second of time.

If the balance vibrated faster, the resistance of the air would be too great.

A pocket watch of this kind would do better with six beats in a second.

A certain size is best for the pallets, or rather a certain proportion between the diameter of the circle described by the edge of the pallets and the diameter of the balance-wheel. This was first suggested to Mr. Harrison from bell-ringing; for he could bring the bell better into a motion by touching it from time to time somewhere near the centre than near the circumference; because in the first case his hand moved quick enough to follow the bell.

The grand principle of the watch is that of giving the greatest motion possible to the balance with a given force. This is done by the scaping and proper quantity of the arc described.

This note was communicated by Mr. Mudge, as also the following: That the balance, by the force from the wheels, without its spring, tends to vibrate once in two seconds.

There are four springs in the watch: first, a main spring; secondly, a spring in the inside of the fusee, to keep it going while it is winding up; thirdly, a spring, which is wound up eight times every minute; fourthly, the balance-spring. The three first were made by Maberley.

The fusee has six turns and a quarter.

The fly serves to moderate the velocity with which the spring nearest the balance would otherwise be wound up.

The pivot-holes are all made in rubies, with diamonds at the ends.

The pallets are diamonds.

One end of the watch in the late voyage to Barbadoes was set higher, because it was not equally adjusted in all positions. Also it was altered and brought back to the same position with respect to the horizon, as the ship lay down on the one or the other tack, by the help of a moveable box with a divided arch.

Mr. William Harrison reckons the greatest roll of a ship fifteen degrees, and the greatest lie-down, when going upon one tack, twelve degrees.

Hold the watch a little back, when in a vertical position, that the face may be a little up.

If the balance-spring be not exactly parallel to the plates, there will be a small difference in the going of the watch, when the face is up or down.

Care is to be used in moving the watch, or in turning it about in order to wind it up, not to give it any quick circular motion in the plane of the balance, as it might possibly stop it. A pocket-watch, which Mr. Harrison has made of this kind, once stopped this way. Turn the watch over upon some diameter of the dial-plate, as an axis, in order to bring it into a convenient position, when you want to wind it up.

Oil must be applied to the pallets and pivot-holes of the watch, but very sparingly.

The watch will go three years without requiring to be cleaned.

At the time of the discovery, in August 1765, Mr. Harrison said, that the watch then went a little slower than it had done, owing to its wanting to be cleaned, viz., two or three seconds per day.

The watch should have a cap, and no outer case, the wooden box in which it should be kept serving that purpose better.

NEVIL MASKELYNE,
Astronomer Royal.

Principles of Mr. Harrison's Time-keeper.

In this Time-keeper there is the greatest care taken to avoid friction as much as can be, by the wheels moving on small pivots, and in ruby-holes, and high numbers in the wheels and pinions.

The part which measures time goes but the eighth part of a minute without winding up; so that part is very simple, as this winding-up is performed at the wheel next to the balance-wheel; by which means, there is always an equal force acting at that wheel, and all the rest of the work has no more to do in measuring time, than the person that winds them up once a day.

There is a spring in the inside of the fusee, which I will call a secondary main-spring. This spring is always kept stretched to a certain tension by the main-spring, and during the time of winding up the time-keeper, at which time the main-spring is not suffered to act, this secondary spring supplies its place.

In common watches in general the wheels have about one-third the dominion over the balance that the balance-spring has; that is, if the power the balance-spring has over the balance be called *three*, that from the wheels is *one;* but in this my time-keeper the wheels have only about *one-eightieth* part of the power over the balance that the balance-spring has; and it must be allowed, the less the wheels have to do with the balance, the better. The wheels in a common watch having this great dominion over the balance, they can, when the watch is wound up, and the balance at rest, set the watch a going; but when my time-keeper's balance is at rest, and the spring is wound up, the force of the wheels can no more set it a-going, than the force of the wheels of a common regulator can, when the weight is wound up, set the pendulum a-vibrating; nor will the force from the wheels move the balance, when at rest, to a greater angle in proportion to the vibration that it is to fetch, than the force of the wheels of a common regulator can move the pendulum from the perpendicular when it is at rest.

My time-keeper's balance is more than three times the weight of a large sized common watch-balance, and three times its diameter; and a common watch-balance goes through about six inches of space in a second, but mine goes through about twenty-four inches in that time: so that had my time-keeper only these advantages over a common watch, a good performance might be expected from it But my time-keeper is not affected by the different degrees of heat and cold, nor agitation of the ship; and the force from the wheels is applied to the balance in such a manner, together with the shape of the balance-spring, and (if I may be allowed the term) an artificial cycloid, which acts at this spring; so that from these contrivances, let the balance vibrate more or less, all its vibrations are performed in the same time; and therefore, if it go at all, it must go *true.* So that it is plain from this, that such a time-keeper goes entirely from principle, and not from chance.

The following is a Description of the Drawings *from which my* Fourth *Time-keeper was made, and the Drawings are also hereunto annexed.*

Fig. I.

A A is the chain-barrel, and B B is a section of it.

C C is the spring-barrel, and D D is a section of it.

E E is a ratchet at the spring-barrel, and F F is a section of it. This ratchet is screwed to the spring-barrel by four small screws at *a a a a*. There is a hole in the pillar-plate of the diameter from the dotted lines *b b*, and that part of the spring-barrel *c c* is to move in this hole without any shake,

in order to set the spring up. The ratchet is also shewn in Figure 13th, by the circle *b b*, and it has thirty teeth, and *c* is the click that holds it.

Fig. 1.

Diameter of the Upper Pivot · ·0575 of an inch.
Diameter of the Lower „ · ·05375 „
Diameter of the Spring Barrel within 1·4 inch.

Diameter of the Spring Arbor - about ·41 of an inch.
Diameter of the Hole in the Centre of [illegible] · - about ·095 „

[The remainder of the PLATES *with their descriptions will be given in our following Numbers.]*

REGULATIONS FOR CHRONOMETER BUSINESS AT GREENWICH.

The following has been received by the principal members of the Trade:—

"ROYAL OBSERVATORY, GREENWICH,
LONDON, S.E.

"1858, *October* 7.

"Sir,—The Astronomer Royal directs me to transmit to you the following extracts from the regulations made by the Lords Commissioners of the Admiralty for the transaction of Chronometer business at the Royal Observatory. I am, Sir, your most obedient servant, "ROBERT MAIN.

"Mr. ——

"*Transaction of Business with Makers of Chronometers.*

"1. No chronometer is to be received from or delivered to a maker except between the hours of nine in the forenoon and two in the afternoon.

"2. The Astronomer Royal will not transact business personally with Chronometer Makers except on the same day, and between the same hours."

AN OLD MUSICAL CLOCK-MAKER IN CLERKENWELL.

It is, we believe, not generally known, that the famous Christopher Pinchbeck, the discoverer of a beautiful alloy of metals called after him *Pinchbeck*, and the inventor of "Astronomico-Musical Clocks,' was a resident in Clerkenwell; but this is evident from the following advertisement of his removal from it, which appeared in *Applebee's Weekly Journal*, of July 18th, 1721:

"NOTICE is hereby given to Noblemen, Gentlemen and Others, that Chr. Pinchbeck, Inventor and Maker of the famous Astronomico-Musical Clocks, is removed from St. Georges Court,* St. Jones's Lane, to the sign of the Astronomico-Musical Clock in Fleet Street near the Leg Tavern. He maketh and selleth Watches of all sorts and Clocks, as well for the exact Indication of Time only, as Astronomical, for shewing the various, Motions and Phenomena of planets and fixed stars solving at sight several Astronomical problems, besides all this a variety of Musical performances, and that to the greatest Nicety of Time and Tune with the usual graces; together with a wonderful imitation of several songs and Voices of an Aviary of Birds so natural that any who saw not the Instrument would be persuaded

* This court was pulled down and rebuilt in 1822, and has since been called Albion Place.

that it were in Reality what it only represents. He makes Musical Automata or Instruments of themselves to play exceeding well on the Flute, Flaggelet or Organ, Setts of Country dances, Minuets, Jiggs and the Opera Tunes, or the most perfect imitation of the Aviary of Birds above mentioned, fit for the Diversion of those in places where a Musician is not at Hand. He makes also Organs performing of themselves Psalm Tunes with two, three, or more Voluntaries, very Convenient for Churches in remote Country Places where Organists cannot be had, or have sufficient Encouragement. And finaly he mends Watches and Clocks in such sort that they will perform to an Exactness which possibly thro' a defect in finishing or other Accidents they formerly could not."

We have also met with the following memorandums copied from an original manuscript, from which it would appear that Pinchbeck's fame as a musical clock-maker got noised abroad :—

"Mr. P." (writes his admiring contemporary) "has finished a fine musical clock, said to be a most exquisite piece of workmanship, and worth about £1500, wch is to be sent over to ye King of France (Louis XIV.) and a fine organ to ye great Mogul, worth £300.

"Mr. Xtopher Pinchbeck had a curious secret of new-invented metal wch so naturaly resembles gold (as not to be distinguished by the most experienced eye) in colour smell and ductibility. Ye secret is communicated to his son."

This was written at the commencement of the last century. At present it is known that pinchbeck metal is an alloy of zinc and copper, in the proportions of three parts of the former to four of the latter, and is also called Prince's metal.

It is probable that, at the period of Pinchbeck's residence in Clerkenwell, it was then, if not earlier, the *locale* of the Watch and Clock trade in London. The early history of Watch and Clock-making in Clerkenwell is however involved in much obscurity ; and we are assured that any memorials of old workmen and their achievements in horology would be of considerable interest, not only to the ingenious artisans at present so employed, but to the public in general, if recorded from time to time in the pages of the Horological Journal.

W. J. Pinks.

TO DRAW A MERIDIAN LINE.

Sir,—The publication in your last number of an Equation Table suggests the desirability of possessing a ready means of getting apparent time. It is not every one who has access to the books necessary for the *data* required. I send you an extract from old Ferguson, which contains a simple and effective method of drawing a meridian line.

"Make four or five concentric circles, a quarter of an inch from one another, on a flat board about a foot in breadth, and let the outermost circle be but little less than the board will contain. Fix a pin perpendicularly in the centre, and of such a length that its whole shadow may fall within the innermost circle for at least four hours in the middle of the day. This pin ought to be about the eighth part of an inch thick, with a round blunt point. The board being set exactly level, in a place where the sun shines—suppose from eight in the morning till four in the afternoon, about which hours the end of the shadow should fall without all the circles. Watch the times in the morning when the extremity of the shortening shadow just touches the several circles, and there make marks. Then in the afternoon of the same day, watch the lengthening shadow; and where its end touches the several circles in going over them, make marks also. Lastly, with a pair of compasses, find exactly the middle point between the two marks on any of the circles, and draw a straight line from the centre to that point ; which line will be covered at noon by the shadow of a small upright wire which should be put in the place of the pin. The reason for drawing several circles is, that in case one part of the day should prove clear and the other part somewhat cloudy, if you miss the time when the point of the shadow should touch one circle, you may perhaps catch it in touching another. The best time for drawing a meridian line in this manner is about the middle of summer, because the sun changes his declination slowest and his altitude fastest in the longest days."

Adam Thomson (our respected fellow member), in his "Time and Timekeepers," also gives the following :—

"If the casement of a window on which the sun shines at noon be quite upright, you may draw a line along the edge of its shadow on the floor, when the shadow of the pin is exactly on the meridian line of the board, and as the motion of the shadow of the casement will be much more sensible on the floor than that of the shadow of a pin on the board, you may know to a few seconds when it touches the meridian line on the floor, and so regulate your clock for the day of the observation by that line and the Equation Table. By this means the inconvenience arising from the imperfection of a public clock, or the negligence of those who have the charge of it, may be avoided."

On some future occasion, should you think the subject appropriate to your Journal, I may probably describe the Transit instrument, and its principles of construction.

I am, your's obediently, Polaris.

Fri. ..	26	12 32·24	0·815	12 32·07
Sat. ..	27	12 12·74	0·844	12 12·57
Sun. ..	28	11 52·50	0·873	11 52·33
Mon...	29	11 31·54	0·902	11 31·37
Tues..	30	11 9·88	0·931	11 9·71

Declinations of the following **Stars**, and Times at which they are on the Meridian at Greenwich, for November, 1858.

Name of Stars.	Day of Mon.	Dec. North	Time of passing the Meridian.
		° ′ ″	h m s
a Tauri (*Aldebaran.*)	8	16 13 31·1	1 20 4·49 a.m.
	18	16 13 31·0	0 40 45·57 „
	28	16 13 30·8	0 1 26·45 „
a Aurigæ (*Capella.*)	8	45 51 3·7	1 58 25·16 „
	18	45 51 5·0	1 19 7·15 „
	28	45 51 6·3	0 39 37·52 „
		Dec. South	
β Orionis (*Rigel.*)	8	8 21 49·5	1 59 53·64 „
	18	8 21 51·1	1 19 34·14 „
	28	8 21 52·9	0 41 16 07 „
a Canis Majoris (*Sirius.*)	8	16 31 15·2	3 30 48·82 „
	18	16 31 17·2	2 51 29·99 „
	28	16 31 19·5	2 12 17·10 „

TO CORRESPONDENTS.

admission of descriptions of New Inventions pages, we desire to avoid giving currency to nciples; and therefore we recommend that all ications upon such subjects should contain of the advantages claimed, and that in the on (particularly of new escapements and other cal arrangements in practical horology) either lute or proportional sizes and angles of all the rts should be added, with an accurate draw-cale, if possible). Attention to such particu-save much trouble, and prevent much mis-on, which would otherwise arise, to the pre-' many valuable inventions.

re glad to have heard again from Corn-is articles are useful and practical, and will be es acceptable.

e sorry Vertical has withdrawn the article we could not find room in our last number; however, he will send his promised papers.

licit papers on a system of Standard Gauges a subject we shall shortly enter upon.

ave received a communication from Mr. , in order to understand which we have pro- Specifications of his Patents; but we must at we are as unable to appreciate the merits tages claimed in the latter, as to decipher nts of the former.

ription and drawing of a New Escapement been received from Mr McCurd but we o sufficient variation from those already well warrant us in incurring the expense of a ts illustration. There is a mysterious connec-een this communication and a letter which ddressed to a member of the Council of the al Institute, offering to prevent the crushing stitute at the moderate charge of one penny The puerility of the arguments against the put forth by some anonymous writers in our respected cotemporary, the *Clerkenwell News* (which the Editor of that journal seems to have duly appreciated) can very well be accounted for on the supposition that the penny-a-liner *A. J.*, alias *Veritas*, alias ——— expected an easy and profitable employment in refuting them even at that low price.

One who Admires Good Work is quite right in considering the article on the American Watch Factory, in our last, as admonitory (which we think was sufficiently evident from the note appended to it), and all concerned in the trade would do well to profit by the admonition. We have not seen a transatlantic watch movement, and therefore cannot judge of its merits, but we have seen within the last week an American gold watch case, of really first-rate workmanship, and we may add, that if Americans are likely to succeed in their movements as they have done with their cases it would be a great piece of wisdom on the part of the English manufacturers and workmen to look about them and take time by the forelock.

**** All Communications for this Journal should be addressed to "The Editor," at the Office,* 19, Saint John's Square, Clerkenwell.

N.B. All Advertisements to be inserted in the Journal, must be received before the 25th of the month.

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BRITISH HOROLOGICAL INSTITUTE.

We are gratified to find that, notwithstanding the opposition that was at first offered to the HOROLOGICAL INSTITUTE, it still continues to add daily to its number of members. To some minds innovation is startling, and often terrific; its first impressions are too often transmitted through the medium of prejudice, which discolours them till time and reason have exerted their influence, and objects are viewed through a brighter atmosphere and subjected to a more calm and dispassionate judgment. New propositions, at first sight incongruous, absurd, and even contemptible, become, first possible, then probable, next demonstrable, and ultimately not only admissible but highly desirable. Such, we have no doubt, will be the fate of the propositions advanced by the advocates of the Institute. Never mind; they will be the more sure and lasting.

The Council have taken premises in Northampton-square, in which, it is anticipated, the Institute will be located early in December; where, in addition to a more central position, there will be a more commodious reading-room, and where we hope the reading of papers, *conversazioni*, and classes will be called into active operation.

Country members are beginning to come in, and many who at first thought ill of the Institute are sending in their names as subscribers. The smallness of the subscription—nearly half the amount of which is returned in the shape of a journal sent by post—ought to be a sufficient inducement for every Watchmaker to become a member, if it were only as an experiment to decide what good might be effected.

Sympathy with its objects is not wanting, of which a convincing proof has been received within the last few days, in the presentation from the Great Seal's Patent Office of a complete set of the Specifications in full, with plates, of all Patents connected with horology from the year 1666 to 1852.

Such an expression of regard for the interests of workmen, and the diffusion of useful information amongst them, ought to go far towards breaking down that exclusive and short-sighted policy which is unfortunately so deeply rooted in the minds of those who have too frequently little or nothing to communicate, but much to learn. We would recommend all who wish to serve the Institute to do so in a friendly spirit, and in a kind and conciliatory tone, thus endeavouring (both by precept and example) to force upon those who have prematurely raised their voices against it, the conviction that the interests of the workman and the prosperity of the Institute are identical.

It has been intimated to us that an improper use is being made of the name of the Institute, and, under the guise of advocacy of its objects, opinions and sentiments are promulgated which most if not all connected with it would unhesitatingly repudiate, and which apparent advocacy has no other object than using the Institute as a hoarding on which to exhibit an insinuating advertisement. To guard against the effects of any such proceedings, we have made inquiry, and can state upon authority that no person has been or will be officially authorized publicly to advocate the interests or objects of the Institute without a notice of such authority previously appearing in this Journal. We may also add—what we are sure it is desired should be perfectly understood—that any attacks or remarks directed against the British Horological Institute, or the mode of conducting its affairs, which the Council consider worthy of refutation or reply, will be replied to in the name of the Council, and that all other remarks, criticisms, or correspondence respecting the Institute or its affairs must be considered as the acts of private individuals, for which the Institute or its Council are in no way responsible.

A Standard Gauge, capable of ready adaptation to the sizing of pivots, mainsprings, dials, movements, &c., has long been a desideratum with the Trade, and we purpose shortly to submit a set of gauges all reducible to one standard, which we think will answer the intended purpose; unless some of our contributors should supersede the necessity of our so doing by suggestions of their own, which we shall be happy to insert, as we are not at all solicitous of depriving any one who has given the subject his attention of the honour or credit of originating such a matter. All we desire is, to see something like system introduced into our manufacture; and we believe that the possession of a set of standard gauges and sizes would form the first element towards success in accomplishing that object.

WHAT IS HOROLOGY?

(*Continued from page* 30.)

CLEPSYDRÆ, OR WATER CLOCKS.

The clepsydra was an horological instrument of great antiquity among Eastern nations, and, it has been asserted, was known before sundials were used; but this is apparently without proof. The name of the original inventor has not been handed down to us; and although the construction has been varied in different ages and countries, according to the different modes of reckoning time, but one principle is the basis of all the forms it has undergone—namely, the constant dropping of water through a small aperture out of one vessel into another. Before the invention of pendulum clocks it was not unusual, in astronomical observations, to measure time by the flowing of water, upon a principle which in its most simple application resembles that of the hour-glass, but which was varied by contrivances for accuracy or ornament. Such an instrument was used up to the time of Galileo, by Tycho Brahé for instance; but as he does not describe it among his instruments, we may suppose that he hardly considered it as important for the observer.

The Chaldeans, it is said, divided the day into twelve *equal* parts, as they supposed, by allowing water to run out of a small orifice during the whole revolution of a star, and dividing the fluid into twelve equal portions, the time answering to each part being taken for that of the passage of a sign over the horizon.

The authority for this statement is Sextus Empiricus, who remarks upon it, that the unequal flowing of the water and the variations of temperature would affect the accuracy of the result. Whatever may have been the case with regard to the Chaldeans, a good presumption of the early use of clepsydræ in India is afforded by the arithmetical treatise of Bhascara, written in the twelfth century, and called "Liliwati." This was the name of the author's daughter, at whose birth it was predicted that she should die unmarried. The father determined to have at least one struggle against the prophecy, and accordingly procured a bridegroom and an astrological determination of a lucky hour. The girl remained in her ornaments near the clepsydra, watching for the moment when she and her parent might set fate at defiance. But at length it was ascertained that the hour was passed, and on examining the clock which should have prevented such a catastrophe, it was found that a pearl had escaped from the *daughter's dress* and closed the orifice through which the water should have flowed. The father, thus grievously baffled, said to his unfortunate daughter, "I will write a book of your name which shall remain to the latest times." The "Liliwati" accordingly was written, and still remains, bidding fair to realize the prediction.

According to Vitruvius, the first improver of the ancient clepsydra or water clock, was Ctesibius, of Alexandria, the son of a barber, who, about 245 years before Christ, seems to have employed himself in devising mechanical contrivances for equalizing the flow of the water, and also for a difficulty of equally formidable character arising from the inequality of the Egyptian hours. They divided the space between sunrise and sunset into twelve hours of the day, and between sunset and sunrise into twelve hours of the night. As the days and nights varied in length at the different seasons of the year, so their artificial subdivisions varied in like proportions, rendering it extremely difficult to contrive mechanism which should be accelerated and retarded accordingly. In fact, it became necessary either to make the water fall irregularly into a receiving vessel with equidistant hour marks, or to have varying hour marks for a regular efflux.

In the account given by Vitruvius he attributes the invention to Ctesibius, but the invention described is so complicated that he cannot intend to assert that this was the first application of the principle even at Alexandria. Some mode of measuring time by the efflux of water, however rude it might be, was used at Athens before the time of Ctesibius, as we may see by various passages in Demosthenes.

Fig. 7.

Probably the first kind of clepsydra is represented in *fig.* 7, the accompanying woodcut. A conical hollow vessel, A, with

a very small hole at the apex, was placed like a funnel in a frame, C C. Another cone, B, precisely similar except that it was solid, was plunged into the first when filled with water to a greater or less height according as the efflux was required to be more or less rapid. Adjusting marks, corresponding to every day and night in the year, were put on a long stem, D, inserted into the broad end of the solid wire B, and kept in its position by the frame. These marks showed how much the inner cone was to be elevated or depressed, thus varying the capacity of the orifice for the efflux of the water. A spout, H, leading from a cistern supplied a constant influx of water, and a waste pipe, I, connected with the top of the conical vessel carried off the superfluous fluid; hence an unvarying height of the watery column above the aperture was preserved, and consequently the pressure remained the same at all times. If, now, we suppose that the receptacle into which the conical vessel discharged itself to be of regular form, as a cylinder, it will be evident that the rising surface of the water within it would point out the lapse of time upon equidistant hour marks placed upon its side. An addition to this clepsydra was a racked bar, E E, which was made to float upon the surface of the water in the cylindrical vessel by a float of wood or cork, so that it rose with the elevation of the fluid. The teeth at the upper part of the bar turned a small wheel, G, on the axis of which an index was placed pointing to the hours on an hour circle.

This may be regarded as the simplest of all true horological machines, water being at once its regulator and maintaining power. The interval between two successive drops was to the clepsydra what one vibration of the pendulum is to a clock or one oscillation of the balance to a watch, and the floating of the indented bar was in place of a weight or spring to move the wheel to which the hand was attached. The adjustment of the two cones was regulated by the latitude of the place. At Alexandria, for instance, the greatest and least velocities of the drops were required to be to each other as 70 to 50, the longest and shortest hours in that latitude being 70 and 50 minutes of equable time.

The next attempt to improve the clepsydra, which we also get from Vitruvius, was by constructing it so that its aperture was adjusted as the year advanced by the putting of an index to the sun's place in an ecliptic circle.

The annexed cut (*fig.* 8) represents an ancient clepsydra with an horary circle and a variable aperture. It consists, first, of a

Fig. 8.

reservoir, A, to the top of which is attached a waste pipe to carry off the superfluous water, and thus keep it at the same level. A pipe, B, projects from this vessel into the rim of a drum, M N, on the front of which is a circle with the signs of the ecliptic engraved thereon. A smaller drum, O F L, passes within the large one, having attached to it an index. This drum has a groove or slot, *a l*, cut through it, tapering in breadth both ways to a point. When in its place this tapering groove comes just under the orifice of the pipe leading from the reservoir. This inner drum turns on a pipe or tube, F, which is continued within and has a funnel at the end (not seen) for receiving the water as it drops through the groove in the drum. The index is double, L for day and O for night, and it will be evident that, as it is turned, the capacity of the orifice is altered and the water passes more or less rapidly through the pipe.

The ecliptic being properly divided, the hand was set to the proper sign in which the sun then was, and was altered as he shifted round the ecliptic. The water thus regulated dropped into a regular cylindrical vessel, H, within which was a float, I, connected by a chain passing over a pulley on an arbor, P, and having a counterpoise, K, at its other end. This pulley carried an index which pointed out the hours on a circle.

The next improvement is that in which Ctesibius was probably more actively con-

cerned as the originator. It was an automaton or self-adjusting machine, and is shown in *fig.* 9. The water dropped into a funnel,

Fig. 9.

A, from the eyes of a figure placed over it, and connected with a full reservoir, thus insuring a constant pressure. The tube conveys the water from M towards B into a cylinder, B C D F, with a float D, and a light pillar C D attached. On the top of this pillar another figure is placed, which points to the divisions on a large column. As the water rises in the cylinder, it also rises in the small tube or short leg of a syphon, F B E, till it reaches the top, when it flows over the bent part, and, by a well-known law, quickly empties the cylinder, bringing down the float, and with it the index to the starting point.

So far it would have measured hours of equal length ; but the Egyptian method required some further contrivance to accommodate it to hours of varying length. This was done by drawing the divisions around the large column out of a horizontal line, so as to vary in their distance on different sides. The water, as it came from the syphon, fell into a chambered drum, K, which turned with the weight as each compartment became filled. On the axis of this drum was placed a pinion, N, which took into a canted or contrate wheel, I, which, by another pinion, H, turned a wheel, G, in the axis of which the column was placed at L. The speed being thus greatly reduced, and adjusted by the relation of the numbers of teeth in the wheels, presented a varying scale of divisions to the index.

(To be continued.)

JOHNSON'S AUTOMATON SECONDS WATCH.

Sir,—I beg to hand you a drawing and description of my patent "Automaton Seconds Watch," by the employment of which periods of time, either long or short, may be measured off with the utmost accuracy, without the embarrassing necessity for dividing the attention between the object to be timed and the instrument. The peculiar advantages of the form adopted are,—independence of the form of escapement or beat of the watch, perfect detachment when not in use, absence of wear, and impossibility of damage. In addition to which, it may be used as a permanent seconds; whilst, not being encumbered by toothed gearing, it gets into action with all the rapidity the wearer can desire. It has been employed by engineers for some time past, and has become a favourite, from the facility afforded by the perfect detachment of the auxiliary mechanism for suddenly shifting the starting point, so as to prepare for any emergency or taking duplicate observations.

I enclose drawings &c. numbered, and shall be happy if you should deem it worthy a place in your "Journal." I am, Sir, your most obedient,

E. D. Johnson.

Description of Plate.

1. Lever to depress Annulus.
2. Seconds hand, on loose axis.
3. Bar attached to said loose axis.

(From an hitherto unpublished Letter of JAMES FERGUSON.)

The following is a letter of James Ferguson's, written about seven months before his death, and hitherto unpublished, which is interesting for its quaintness as well as for referring to a problem in wheel-work which is somewhat difficult to understand. The recent discussion about the rotation or non-

must it turn the others?' Says he, 'Your question is almost an effront to common sense; for every one who knows anything of the matter must know that, turn the thick wheel which way you will, all the other three must be turned the contrary way by it.' 'Sir,' says I, 'I believe you think so.' 'Think!' says he, 'it is beyond a thought; it is demonstration that they must.' 'Sir,' said I, 'I would not have you to be sure, lest you

possibly be mistaken; and now, what would say, that, turn the thick wheel whichever way you will, it will turn *one* of the thin wheels *the same way*, the other *the contrary way*, and the third *no way at all!'* Says he, 'I should say that there was never anything proposed that could be more absurd, as being not only above reason, but contrary thereto, and also to plain fact.' 'Very well,' says I; 'now, Sir, is there anything in your ideas more absurd about the received doctrine of the Trinity than in this proposition of mine.' 'There is not,' said he; 'and if I could believe the one, I should believe the other too.' 'Gentlemen,' said I, (looking at the company), 'you hear this; bear witness to it.' The watchmaker asked me whether I had ever made or seen such a machine? I told him I had not, but I believed I could make it, although I had never thought of it till that instant. 'My God!' says he, 'your head must be wrong, for no man on earth could do such a thing.' 'Sir,' said I, 'be my head wrong or right, I believe I can not only do it, but even be able to show the machine, if I may be admitted into this company on this day se'nnight.' The company, who, with serious faces were very attentive to all this, requested that I would come.

'So I made my machine, all of wood, and carried it (under my coat) to the same room on the day appointed; and there was the watchmaker. 'Well, old friend,' says he, 'have you made your machine?' 'Yes, Sir,' said I; 'there it is; let us take it to pieces; are these wheels fairly toothed, and fairly pitched into the thick wheel?' 'Yes, they are,' said he. I then turned round the great wheel, whose teeth took into those of the three thin wheels, and asked him whether the uppermost thin wheel did not turn the same way as the one that did turn it? whether the next below did not turn *the contrary way*, and the lowermost thin wheel no way at all?' 'They do,' said he; 'but there is a fallacy in the machine.' 'Sir, said I, do you detect the fallacy, and expose it to the company.' He looked a long while at it, took it several times in pieces, and put it together again. 'Sir,' said I, 'is there any fallacy in the machine?' 'I confess,' said he, 'I see none.' 'There is none,' said I. 'How the devil then is it,' said he, 'that the three thin wheels should be so differently affected? The thing is not only above all reason, but is even contrary to all mechanical principles!' 'For shame, Sir,' said I, 'ask me not how it is, for it is a simpler machine than any clock or watch you ever made or *mended*; and if you may be so easily nonplused *by so simple a thing* in your own way of business, no wonder you should be so about the Trinity. But learn from this, not for the future to reckon *every* thing absurd and impossible that you cannot comprehend. But now, I hope you remember what you said at our last meeting here—namely, that if you could believe such a thing as this, you could then believe the doctrine of the Trinity. You own the truth of the machine; what do you say to your promise? He humm'd and ha'd, and asked me whether I would let him take it home to consider it. I told him he might; but desired he would bring it me to-morrow morning. He promised he would, and did so; but gave it to me with some hearty curses, telling me he saw it was true, but did not understand it, and wanted me to explain it to him; which I refused. I kept it for six years without finding any person who could explain the principles on which it acted, and then put the Sun and Earth with the ecliptic and Moon's orbit to it, seeing it would then be a kind of orrery, and published the description, which I send you, in order to save myself the trouble of explaining it any longer. As it is now finished, it makes a good orrery for showing the causes of the different seasons, times of eclipses, &c.

4, Bolt Court, Fleet Street, London.
April 10, 1776.

AMERICAN WATCHES.

We have just received a watch the produce of the American factory at Waltham, Massachusets, of which we gave an account in No 2 of the Journal. The watch is a silver double-bottom dome hunter, bearing the name of Appleton and Tracey, Waltham, Massachusets, No 5438. We have not had time to make so minute an examination as to be able to report upon its quality. The external appearance indicates cheapness, and there is enough in it to prove that where it has been made better *may* be produced, and we would seriously advise English manufacturers and workmen to lose no opportunity of preventing these articles from getting a footing in colonial markets, where, whatever their quality may be found to be, they could not fail to affect to some extent the sale of English watches. Old notions and prejudices must be cast aside, and advantage taken of every means by which the standard of quality in our own work may be maintained, while it is produced at the lowest possible price, which, considering the relative value of labour in this country and in America, ought

to enable the English manufacturer to keep up a successful competition with our Transatlantic neighbours, who will let no opportunity slip of "going a-head."

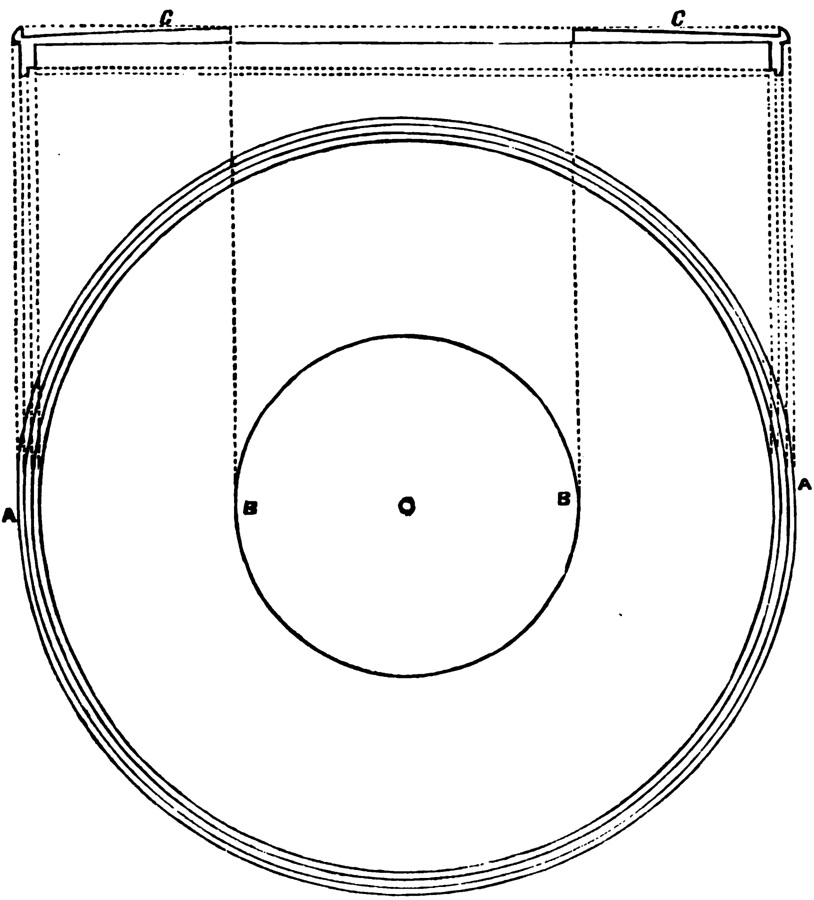
We may remark here, that the specimen we have received is upon the going barrel principle, devoid of any stop work; it has a sunk seconds, four pairs of holes jewelled, and a lever escapement. The external diameter of the case is 2·14 inches, its thickness about ·44 of an inch and the size of the movement taken across the pillar plate 1·795 inch, and of such an appearance and style as would harmonize with the character and costume of a back-wood's man. In our next we will report on its quality.

PLATES ILLUSTRATIVE OF THE PRINCIPLES OF MR. HARRISON'S TIME-KEEPER.

(*Continued from page 42.*)

FIG. 2.

Height of these pillars, about ·1375 of an inch.



A A is the Brass Edge, B B the Hole in the middle of it, and C C is a Section of it. This Brass Edge is supported by six Pillars, and their places are represented in Figures 13 and 14, by six Circles, *a a a a a a*.

TABLES FOR FACILITATING THE RATING OF CHRONOMETERS AND WATCHES, &c., IN DIFFERENT TEMPERATURES OR POSITIONS.

TABLE I.

hours.	min. 0	min. 5	min. 10	min. 15	min. 20	min. 25	min. 30	min. 35	min. 40	min. 45	min. 50	min. 55	hours.
1	A	B	C	D	E	F	G	H	I	K	L	M	1
2	N	O	P	Q	R	S	T	U	W	X	Y	Z	2
3	A	B	C	D	E	F	G	H	I	K	L	M	3
4	N	O	P	Q	R	S	T	U	W	X	Y	Z	4
5	A	B	C	D	E	F	G	H	I	K	L	M	5
6	N	O	P	Q	R	S	T	U	W	X	Y	Z	6
7	A	B	C	D	E	F	G	H	I	K	L	M	7
8	N	O	P	Q	R	S	T	U	W	X	Y	Z	8

SIR,—It was suggested to me a short time ago, by Mr. E. D. Johnson, that a Table of the proportional parts of a day reduced to one common denomination would be useful in timing chronometers under different temperatures. I immediately gave the subject my attention, and the result has been the production of two Tables, which I call "TIMING TABLES, Nos. 1 and 2," and which I beg to present for insertion in *The Horological Journal*, as they may be interesting to many of your readers who are not actually engaged in the business of Timing.

I have also determined to publish the Tables complete on a card, which will be sold separately, as many who may require to use them frequently may not like to deface their Journal by the wear to which constant use would subject it.

The Tables are too extensive to publish both in one number; I therefore send Table No. 1 only for insertion in No. 4 of the Journal, and will have Table No. 2 ready for the number to be published in January next.

In order to use the Tables, it will only be necessary to note the time during which the instrument has been under trial at any given temperature or in any given position, and the amount of its gain or loss during that period. Then look into Table No. 1 for that time, viz., in the hour column for the hours, and in the top row for the minutes; then proceed with the finger or a pointer along the row of letters opposite the hour, until it comes under the proper number of minutes in the top row, and note the name and kind of letter standing on the place of intersection under the pointer.

For example, suppose the time of trial to have lasted 4h. 25m., then opposite to 4 hours and under 25 minutes will be found the Egyptian letter **S**. With this letter, enter that section of Table No. 2 which is distinguished by letters of the same character, and by attending to the explanation which will be given with the Table, the daily rate during the period under trial will be found by a simple inspection,—the whole operation not occupying more than ten seconds.

JAMES BREESE, SEN.

Secretary to the Horological Institute.

P. S.—Having found the given letter in Table No. 1, it will be as well to attach to it its proper name—whether *Roman*, *Egyptian*, *Open*, or *Old English*—before going to Table 2.

DECIMALS. No. 2.

Continued from page 13.)

Our young readers who have followed us through article No. 1 on this subject will, if they have thoroughly understood what is there advanced, be quite competent to follow us with perfect ease through the present. In these articles we shall endeavour to divest the subject as much as possible of all technicalities—we shall talk to our readers in the most familiar style, believing that to be the one which is most impressive, and most efficacious in conveying that sort of knowledge which it is our object to impart. No one can expect to become an arithmetician without performing a great number of examples, nor can any of our young friends expect to become familiar with or expert in the portion called decimals without performing his due proportion of them. We cannot afford space for a sufficient number of examples to render the pupil proficient, but we will, with the few we can afford room for, lead him so to couple them with the reason for the mode of operation employed that he shall with a little mental exertion soon become his own tutor, and never be at a loss for an example or a proof.

Having shewn what decimals are,—how to discover the value of any figure by its position in the row in which it occurs, and the law or order in which they vary in value, need we say, Do you understand all this? If not, read again and again, for until you do, you are not in a condition to go a step further. If you do, just look at these three rows of figures, in Example No. 1, in the margin; for we are now going to shew you how to add numbers together into the composition of which decimals enter, or, in other words, the *Addition of Decimals.* Now, add up these three rows in columns—(and mind the distinction between the words *column* and *row*—we have known the confounding of these two terms to cause an amount of confusion and perplexity very vexatious and disheartening to the pupil.) Add them up just as you would an ordinary example in addition of whole numbers; and observe, that Two hundred and ninety six—decimal eight, nine, four, is called the *sum.* It is incorrect to call any example a sum, although it is a practice almost universal, even amongst teachers. The word *sum,* in arithmetic, means the result of any addition, and should not be used in any other sense.

No. 1.

21·578
92·114
183·202
296·894

No. 2.

·071
·2144
·31
·2
·7954

No. 3.

·111
·62
·7184
·402
·0006
·01
1·8620

No. 4.

·99
·99
·99
·99
·99
·99
·99
·99
·99
·99
·99
·99
11·88

Now add up Example No. 2, and read the *sum;* which is, Decimal seven, nine, five, four. Proceed to Examples 3 and 4, and in like manner read the sums.

Now all this, you will say, is very simple, and requires no explanation. True; but have you paid attention to that little dot called the decimal point, whose place and use were described in our former article? Do you understand its use? If you do, then are you master of addition of decimals. But, lest you should not, we will go through these examples with you; it may be tautological, but it is better that a little tautology should be endured than that you should remain in ignorance.

Observe first, that in all cases the decimal point marks the separation of the decimals on the right from the whole number on the left of it. Refer to the examples again, and you will find that if there is but one decimal figure, it stands next to the dot on the right, and therefore stands for tenths, and in placing any decimal number on paper, the first or left hand figure of decimals must always be placed next to the dot, and all the other decimal figures will then fall in their right places. The reason is clear—it is, that each figure will thus fall into that vertical column which indicates its value, whether it be tenths, hundredths, or thousandths, &c., so that in adding up any column, thousandths will always be added to thousandths—hundredths to hundredths—tenths to tenths, &c., in the same way as the units, tens, and hundreds are in the addition of whole numbers. If we now take Example No. 1, in which in the decimal part $\frac{578}{1000}$ $\frac{114}{1000}$ and $\frac{202}{1000}$ are added together, and their sum or total is ·894 or $\frac{894}{1000}$ which not being equal to unity or *one,* does not in any way affect the whole number in connection with it, viz. the 296, the sum will be read Two hundred and ninety six—decimal eight, nine, four.

In Example No. 2, there are added together decimal nought, seven, one ($\frac{71}{1000}$), decimal two, one, four, four ($\frac{2144}{10000}$); decimal three, one, ($\frac{31}{100}$); and decimal two, ($\frac{2}{10}$); and their sum is decimal seven, nine, five, four, being equivalent to $\frac{7954}{10000}$.

On adding together the decimals in Example No. 3, the values of which we think we need not repeat separately (as our young friends will, we expect, ere this, be able to read them for themselves), the result or *sum* is found to consist of one figure more

than the number of figures in the longest row of decimal figures. This arises from the last column (that is, the column of tenths) amounting to 18; but as 18 tenths cannot be expressed in one figure, the 8 is placed under the column of tenths, and the remaining 10 tenths are carried forward as a unit to the next place to the left, which is the place of units or *ones* (being, in fact, the whole number one), between which and the decimal part of the number the dot or point must be placed. Example No. 4 contains 12 repetitions of the decimal ·99, and their sum will amount to 11·88. In this case the sum of the column of tenths will consist of three figures, viz., 118 tenths; therefore the two ones are carried forward, the one taking the place of units and the other that of tens in the whole number Eleven, and the sum would be read, Eleven—decimal eight, eight, and would be Eleven and eighty-eight hundredths.

The addition of decimals should now be perfectly intelligible to our young readers,—and we hope it is so.

The substraction of one number from another in which decimals are concerned is a very simple matter. As in the common subtraction of whole numbers, the larger number must first be written down, and the less number (which is to be subtracted) written underneath it, with this precaution, that the decimal point in the less must always stand directly under the decimal point in the greater. The greater number may always be known either from its containing the greater whole number, or if both numbers consist of decimal figures only, that which has the greater figure nearest to the decimal point is the greatest number of the two, and must be written down first. In order to render this clear, the decimal numbers in the subjoined example (No. 5,) are so placed that the greatest stands in the top row, and the remaining ones decrease in value in their order of succession downwards.

Ex. 5.

·8
·7643
·55
·294
·1764
·0099
·00089

Examples 6, 7, 8, 9, will be quite sufficient to illustrate the subtraction of decimals, which is performed in precisely the same manner as in common arithmetic, that is, where the upper figure is less than the lower one, by adding ten to the upper, then subtracting the lower one and carrying one to the next lower figure on the left, to which it must be added previous to performing the next subtraction.

Ex. 6.

·82
·77
———
·05

Ex. 7.

27·59
14·91
———
12·68

Ex. 8.

348·
·628
———
347·372

Ex. 9.

486·001
485·999
———
·002

In all cases we recommend the young student to read, in the way we have pointed out, every number he may have to commit to paper; this will very much facilitate his progress. We shall conclude this article by reading the remainders in the examples numbered 6, 7, 8, 9. Thus, in Ex. 6 the remainder is Nought, five (five hundredths); in Ex. 7 it is, Twelve—decimal six, eight (Twelve, and sixty-eight hundredths); in Ex. 8 it is Three hundred and forty-seven—decimal three, seven, two (three hundred and forty-seven and 372 thousandths); and in Ex. 9, Nought, nought, two (two thousandths).

In our next Number we shall explain the multiplication and division of decimals; after which we shall furnish some examples for practice, all of them being taken from subjects connected in some degree with the art or practice of horology, or some of the branches of trade connected therewith.

ACCURACY OF CHRONOMETERS.

Mr. Editor,—May I be permitted to state, that Harrison did not receive the last portion of his reward until he had constructed a model of his timekeeper, and a timekeeper was constructed on his principles by Mr. Kendal.

The instrument he produced was committed to the care of Mr. Wales on his voyage round the world with Captain Cook, in the years 1772, 1773, and 1774, and it so fully justified Harrison's expectations in this severe trial, that the House of Commons ordered the remaining sum of £10,000 to be paid to him.

As an illustration of the improvements which have since been made in the construction of chronometers, the following circumstance, mentioned by Dr. Arnott as having occurred to himself, is of great interest.* "After several months spent at sea," he says, "in a long passage from South America to Asia, my pocket chronometer and others on board announced one morning that a certain point of land was then bearing north from the ship at a distance of fifty miles. In an hour afterwards, when a mist had cleared away, the looker-out on the mast gave the joyous call of 'land a-head,' verifying the report of the chronometers almost to one mile, after a voyage of thousands. It is allowable at such a moment, with the dangers and un-

* See Carpenter's Popular Cyclopædia, p. 352.

certainties of ancient navigation before the mind, to exult on what man has now achieved. Had the rate of the wonderful little instrument in all that time increased or decreased ever so slightly, its announcement would have been useless, or even worse; but, in the night and in the day, in storm and in calm, in heat and in cold, its steady beat went on, keeping exact account of the revolutions of the earth and the positions of the stars, and in the midst of the trackless waves, which retain no mark, it was always ready to tell its magic tale, indicating the very spot of the globe over which it had arrived."

It is surprising, that in spite of the great advantages resulting from the use of chronometers in navigation, many ships are sent to sea without them, even for long voyages. Not unfrequently must it occur, that the knowledge of the exact position of the ship which may be obtained by the chronometer produces a great saving of time, as well as contributes to the avoidance of danger. A remarkable instance of this was mentioned to the writer, a few years since, as having just then occurred. Two ships were returning to London about the same time after long voyages, one of them provided with chronometers, the other destitute of them. The weather was hazy and the winds baffling, so that no ship whose position was uncertain could be safely carried up the British Channel. Confident in his position, however, the captain of the first ship stood boldly onwards and arrived safely in the Thames, whilst the other ship was still beating about in uncertainty near the entrance of the Channel. The first ship discharged her cargo, took in another, set sail on a fresh voyage, and actually in running down the Channel encountered the second ship still toilsomely making her way to her port.

Of the degree of accuracy which chronometers are capable of exhibiting some idea may be formed from the following statement, kindly communicated to the writer by a gentleman practically conversant with them. A chronometer made by Molyneux had its daily rate determined, in August, 1839, to be a loss of seven seconds per day. It was then placed in a ship which traded to the coast of Africa, and was consequently exposed to great variations of temperature, yet, when again placed under careful observation, in November, 1840, (sixteen months afterwards), its daily loss had changed only to 6·7 seconds, being a difference of only 3-tenths of a second per day.

As opportunities for ascertaining the real position of a ship without chronometers frequently occur at sea, any error in them may almost always be detected before it has accumulated to any great extent; but, even supposing that no such opportunity had occurred for six months, and that the alteration of the rate had taken place at once and had been entirely unknown, the whole error would have been under a minute of time, and consequently less than fifteen miles of space. Another chronometer, constructed by *Muston*, which had made the same voyage, and been out about the same length of time, had its previous gaining rate of 1·9 seconds per day increased to 2·3 seconds, the difference here being 4 tenths of a second.

It is customary for two or more chronometers to be carried by the same ship, that they may check one another, for if one alone were trusted to, an accidental irregularity in its going might lead to great error. The average of several—their errors counter-balancing each other—will be most likely to give the real time with great exactness. I am, Sir, yours respectfully,

81, St. John-street-road. W. B. CRISP.

A NEW MATERIAL FOR DIAL PLATES.

To the Editor of the HOROLOGICAL JOURNAL.

SIR,—A white, unoxydizable, metallic dial has long been a desideratum with watchmakers. Silver is a beautiful material, but the rapid manner in which it oxydizes is objectionable. Platina has been tried, but the inability to produce a dead white surface has prevented its coming into use. The new metal *aluminium* can now be obtained for about the same price, *in bulk*, as silver; and it has lately been discovered that, if immersed in a solution of caustic potash, a beautifully frosted unoxydizable surface is produced. I beg to call the attention of dial-finishers to this fact, as here we have a white metallic unchangeable dial that probably may come into general use.

The advantage of a metallic over an enamel dial is, that the divisions for the minutes can be graduated by the engine; for although a few enamel dial painters divide exceedingly well, they can never equal the engine in accuracy.

I am, Sir, your obedient servant,

CORNHILL.

[The above letter is well worth the attention of dial finishers; and there are two other points to which it is very desirable that the parties engaged in that branch of the business should pay particular attention,—namely, accuracy of division and perfect concentricity of the minute and seconds circles with the centre

and fourth wheel pinions. Watches, even ‹ the commonest description indicate the varioı portions of time with great accuracy, bı these functions are sadly belied on the dial b one or both the errors above named. A eccentricity of only ·01 inch, or the one hundredth part of an inch, would cause a error in marking the time of half a second i excess on one side of the dial, and as much i defect on the opposite side; in fact, whereve there is an error of this nature, it is equiva lent to a badly-divided circle, as there wil be but two points in the circle where the han will mark the time correctly.

It may be difficult to correct these defect in an enamelled dial, which is subjected t the action of the fire after being painted; bu there can be no excuse for such defects in metallic dial.—ED.]

MEMOIR OF GRAHAM.

GEORGE GRAHAM, whose name is familia to every tyro in horology, was born at Gratwick, in Cumberland, in 1673. In early lif he came to London, and was received into th family of the celebrated Tompion (of whom we hope soon to be able to furnish a memoir), by whom it appears he was treated with paternal affection until the death of the latter.

To say that Graham was the most eminent of his profession, would be to award him but a small portion of that commendation—and we might add, veneration—to which his numerous inventions and his character alike entitle him. There is no doubt he was the best general mechanic of his age, to which he added a thorough knowledge of practical astronomy; so that his inventions in horology not only gave to the machines for measuring time, to which they were applied, a degree of accuracy and perfection which they had never before attained, but he became the author of several astronomical instruments by which great advances were made in that science.

The great mural arc in the Greenwich observatory (now disused) was made for Dr. Halley under the immediate inspection of Graham, and was divided by Graham's own hand; and it is from this great and incomparable original that the best foreign instruments are (or at least were till very lately) copies, made by English artists. The zenith sector by which Dr. Bradley discovered two new motions in the fixed stars, was of Graham's invention and make. He was the author of a machine which comprised the whole planetary system within the dimensions of a small cabinet; from which, as a model, almost all the more modern orreries have been taken.

When the French academicians were sent to the north to make observations for determining the figure of the earth, Graham was selected as the most proper person in Europe to supply them with the necessary instruments; and by means of those instruments they were enabled to finish their observations in one year, while those who went to the south, and were not provided from the same source, encountered much embarrassment, and were greatly retarded in their operations.

To horology he contributed three most important inventions, which alone would have been sufficient to immortalize his name. These were, 1st, the dead-beat escapement for clocks (which also bears his name); 2d, the horizontal escapement, which is a modification of the former, being in fact a dead-beat, with the pallets taking over one tooth only, and the inclined planes on the teeth of the wheel instead of on the pallets. The third was the mercurial pendulum. This last invention, as an adjunct to the dead-beat, stamps Graham as a mechanical and scientific genius of the first order. The combination of great mechanical skill with the thorough knowledge of principles possessed by Graham enabled him to give his inventions to the world in a state of completeness of which few (if any) unscientific inventors can boast; of which no greater proof need be required than the three inventions last mentioned, which but few have attempted to improve, and none have succeeded in the attempt.

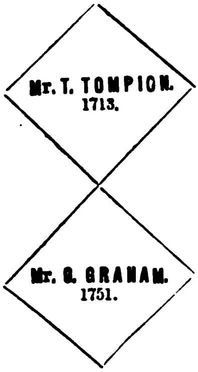
Mr. Graham was for many years a fellow of the Royal Society, to which he communicated several important and ingenious discoveries, which may be found in the Philosophical Transactions, vols. 31 to 42. They are chiefly on astronomical and philosophical subjects, amongst which may be mentioned, in addition to his mercurial pendulum, a horary variation in the magnetic needle, and many curious and interesting particulars relating to the true length of the simple pendulum, upon which he continued to make experiments till the time of his death, which occurred in 1751, in the 78th year of his age.

Like all true sons of science, he was in his disposition as kind and communicative as his genius was acute and penetrating; and his principal aims were the advancement of science, the ennobling his profession, and the benefit of mankind.

George Graham was interred in the nave of Westminster Abbey, in the same grave with his master and friend, Thomas Tompion, and a small lozenge-shaped marble slab bore the following inscription:—

"Here lies yᵉ body of Thomas Tompion, who died Nov. 20th, 1713, aged 75. Also, George Graham, Watchmaker and F R S., whose curious inventions do honour to yᵉ British genius, whose accurate performances are yᵉ standard of mechanical skill. He died yᵉ 16th of Nov. 1751, in the 78th year of his age."

But these truly great men have been deprived of this tribute to their memory, by the removal of the slab by order of the Dean in 1838, when the following was substituted in its place.



Such is all that is left to mark the resting-place of two great benefactors of mankind,—Thomas Tompion, the father of clock-making, and honest George Graham, a pupil every way worthy of his great master!

THE INSTITUTE AND ITS SUPPORTERS.

SIR,—Referring to the Address just issued by the Council of THE BRITISH HOROLOGICAL INSTITUTE, I not only think that the Trade have much to thank the Council for, in relation to the efforts they are making to advance the science and art of Horology, but that the Address will do much to diminish that feeling of jealousy which is found not only among manufacturers but workmen.

As the Workmen are thereby invited to avail themselves of the Journal "as a means of communication," I am induced to draw your attention to the inclosed pamphlet relating to a meeting of watchmakers held last year at Shaftesbury Hall. You will perceive, by an Address dated March 10th, 1857, and appended to the report of the proceedings of that meeting, that an effort was then made by the workmen to establish a Watchmakers' Institute. In looking over the Address of the Council, I do not find any reference to that effort, which all must admit was well conceived on the part of the working men—unless, indeed, I have misconstrued the meaning of a certain paragraph. It would be rather a difficult task to find out who originated the *idea* of an institution in connection with the Watch Trade; but until it is proved to the contrary, *I* think that the workmen themselves were the first to enter upon the field of *action*, although (if I may so express it) our efforts did not meet with the support we so much desired. But if there is any merit in being the first to take the initiative, I am sure it will be willingly conceded to the workmen, especially as I feel that the best interests of the Institute will be found in giving to one and all their just due.

Whenever any good cause is being promoted, it is the duty of all true men to be found among its supporters, more particularly when that support is likely to improve and elevate the social condition and practical knowledge of all connected with the profession; I therefore trust and believe that the Institute (from whatever source it originated) will have the co-operation of a vast majority of the Trade.

Merely to show that when mind is once directed to any particular subject, how often it arrives at the same ideas, I may state, that many of the leading features in the present Institute are really put forward in the address to which I have called your attention,—the existence of that address being no doubt unknown to the Council.

Believing the Institute will be a boon to the entire Horological community, and trusting it may meet with the success it justly deserves, is the sincere wish of, AN ARTISAN.

New North Road, Nov. 8. 1858.

[We readily give insertion to the foregoing letter by ARTISAN. The pamphlet referred to must have had a very limited circulation; no one to whom we have mentioned the subject having previously seen it. We cannot, however, but admire the reciprocity of good feeling evinced by the writer.—ED.]

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIME-KEEPERS.

(*Continued from page* 34.)

1695, September 23.—No 344.

BOOTH, EDWARD, and HOUGHTON, WILLIAM.—"A new sort of watch or clock, with the ballance wheele or swing wheele either flatt or hollow, to worke within and crosse the center of the verge or axis of the ballance or pendulum, with a new sort of teeth made like tinterhooks, to move the ballance or pendulum withall, and the palletts of the axis or verge of the ballance or pendulum are to be circular, concave, and convex, or other teeth or palletts that will not goe but by the helpe of the spring to the ballance, which will make such watch or clock goe more true and exact, and be of greater vse to our subiects both at sea and land, than any other heretofore made or now used."

[No Specification enrolled. Letters Patent printed, 3*d*.]

EQUATION OF TIME TABLE,
For December, 1858.

Day of the Week.	Day of Mnth.	At Apparent Noon Equation of Time to be *subtracted* from Apparent Time.	Difference for One Hour.	At Mean Noon. Equation of Time to be *added* to Mean Time.
		m. s.	s.	m. s.
Wed ..	1	10 47·54	0·958	10 47·37
Thurs.	2	10 24·54	0·985	10 24·37
Fri. ..	3	10 0·90	1·011	10 0·73
Sat. ..	4	9 36·64	1·035	9 36·47
Sun. ..	5	9 11·80	1·057	9 11·64
Mon...	6	8 46·43	1·079	8 46·27
Tues..	7	8 20·53	1·100	8 20·37
Wed ..	8	7 54·14	1·119	7 53·99
Thurs.	9	7 27·30	1·136	7 27·16
Fri. ..	10	7 0·03	1·152	6 59·90
Sat. ..	11	6 32·37	1·168	6 32·24
Sun. ..	12	6 4·34	1·181	6 4.22
Mon...	13	5 35·99	1·193	5 35·88
Tues..	14	5 7·35	1·204	5 7·25
Wed ..	15	4 38·45	1·214	4 38·36
Thurs.	16	4 9·31	1·223	4 9·23
Fri. ..	17	3 39·97	1·230	3 39·90
Sat. ..	18	3 10·46	1·236	3 10·40
Sun. ..	19	2 40·80	1·241	2 40·75
Mon...	20	2 11·02	1·244	2 10·98
Tues ..	21	1 41·17	1·246	1 41·14
Wed...	22	1 11·27	1·247	1 11·25
Thurs.	23	0 41·34	1·247	0 41·33
Fri. ..	24	0 11·42	1·245	0 11·42
		added to Apparent Time.		*subtracted* frm Mean Time.
Sat. ..	25	0 18·46	1·242	0 18·45
Sun. ..	26	0 48·27	1·238	0 48·25
Mon...	27	1 17·99	1·233	1 17·96
Tues..	28	47·58	1·226	1 47·54
Wed ..	29	2 16·99	1·217	2 16·94
Thurs.	30	2 46·19	1·207	2 46·13
Fri. ..	31	3 15·15	1·195	3 15·09

Declinations of the following Stars, and Times at which they are on the Meridian at Greenwich, for December, 1858.

Name of Stars.	Day of Mon.	Dec. North	Time of passing the Meridian.
		° ' "	h m s
a Tauri (*Aldebaran.*)	7	16 13 30·6	11 22 7·60 p.m
	17	16 13 30·3	10 42 48 56 ,,
	27	16 13 30·1	10 3 29·47 ,,
a Aurigæ (*Capella.*)	8	45 50 67·9	0 0 28·58 a.m
	17	45 50 69·2	11 21 9·60 p.m
	27	45 50 70·7	10 41 50·56 ,,
		Dec. South	
β Orionis (*Rigel.*)	8	8 21 54·8	0 1 56·81 a.m
	17	8 21 56·5	11 22 37·78 p.m
	27	8 21 58·2	10 43 18 71 ,,
a Canis Majoris (*Sirius.*)	8	16 31 22·1	1 32 52·21 a.m
	18	16 31 24·6	0 53 33·25 ,,
	28	16 31 27·1	0 14 14·26 ,,

QUESTION FOR SOLUTION.

Suppose the internal diameter of a watch barrel to be ·8 of an inch, the arbor to be one third of the said diameter, the spring is to occupy one half the area left unoccupied by the arbor. It is required to know what will be the diameter of the spring when unwound, what the diameter of the space between the spring and arbor, and what portion of the area of the whole barrel is occupied by the arbor; also what must be the thickness and length of the spring which shall fill the space allotted to it (when unwound) with exactly 13 turns in the barrel.

Horologiorum Faber.

TO CORRESPONDENTS.

In the admission of descriptions of New Inventions into our pages, we desire to avoid giving currency to false principles; and therefore we recommend that all communications upon such subjects should contain evidence of the advantages claimed, and that in the description (particularly of new escapements and other mechanical arrangements in practical horology) either the absolute or proportional sizes and angles of all the acting parts should be added, with an accurate drawing (to scale, if possible). Attention to such particulars will save much trouble, and prevent much misconception, which would otherwise arise, to the prejudice of many valuable inventions.

Thos. Charles Scotchford.—We have received your communication, but have understood that the party alluded to is about to publish (by subscription) a volume on the subject, which will probably accomplish the object you have in view in making the suggestions in your letter. At the same time we are quite aware of the requisites for the undertaking; and if it should remain to be done in the Journal, we shall take care that it be done properly.

A Manufacturer.—In reply to a Correspondent who signs himself a Manufacturer, we can inform him, that the fact he alludes to is by no means new, as we know that it has been for some years the practice to send out English unfinished watch movements to Geneva, in order that the Swiss may more effectually imitate English work in foreign markets.

NOTICE.

We were so unfortunate as to have a mistake in the Table of Stars given in No 3. If our readers will kindly cancel the last leaf in the first edition, they may receive a corrected one in return by applying at the Office of the Institute.

*** *All Communications for this Journal should be addressed to "The* Editor," *at the Office*, 19, Saint John's Square, Clerkenwell.

N.B. All Advertisements to be inserted in the Journal, must be received before the 25th of the month.

London: Published by R. Macdonald, 30, Great Sutton Street Clerkenwell; may be had at the Office of "The British Horological Institute," 10, St. John's Square, Clerkenwell; and of all Booksellers and Newsvenders.

WHAT IS HOROLOGY?

Clepsydræ, or Water Clocks.

(*Continued from page* 48.)

The clepsydra was introduced into Greece by Plato. Athenæus relates that the so-called "divine philosopher" invented a night clock, which was a clepsydra or water clock that played upon flutes certain sounds which indicated the hour of the night at a time when they could not be seen on the index. Athenæus says of it, that it resembled in appearance a round altar; that it was not to be ranked with stringed instruments, but was a wind instrument composed of pipes, the orifices of which being toward the water as it fell, produced a soft and pleasing sound. The introduction of the clepsydra into Rome took place about 157 years before Christ by Scipio Nasica. Pliny tells us, that Pompey brought a valuable one among the spoils from the eastern nations, which he made use of for limiting the speeches of the Roman orators. (It is much to be regretted that horological machines are not more used for the purpose in these days.) Julius Cæsar is said to have met with an instrument of the kind in England, by the help of which he observed that the summer nights of this climate are shorter than they are in Italy, which fact is mentioned in his Commentaries. It is most probable that they had been long known to our ancestors in consequence of the very early intercourse they had with the Phenicians.

We have spoken of the different manner in which time was reckoned by ancient eastern nations, and of the difficulty which was experienced in contriving mechanism which should accommodate its results accordingly. It may be desirable here to say a word or two on the method of counting time which has been handed down to us, and is now used by universal consent. We may first remark, that all divisions of time must necessarily be artificial. An hour or a year are not strictly natural divisions, but are adopted as the most convenient artificial divisions perfected and settled by the experience of centuries.

Clearly the apparent motion of the heavenly bodies would be the basis upon which a permanent system of time must be erected. In the sublime words of the inspired writer, "There is no speech nor language where their voice is not heard." Their indications are universal and incontrovertible, and their effects in the change of the seasons come home to the perceptions of the meanest individual. We see thus, at once, how Astronomy and Horology must go hand in hand. The first, as relating to the motions of sun, planets, and stars, furnishing the data; and the latter, on the basis thus laid down, building up an artificial system which shall be as a standard of time to society at large, and also a perfect means whereby the astronomical observer can register his observations, and predict with marvellous accuracy the coming changes in the heavens.

The Roman calendar, as corrected by Augustus, is the system of computing time which is now in use, with a slight alteration made by the Council of Trent, and called the "Gregorian reformation." Of mere matters of calendar it would be foreign to our subject to speak; suffice it to give a few particulars of the results thus involved. The civil or tropical year thus settled is the interval between the time when the sun moves from the vernal equinox (or point where it crosses the equator) and the time when it reaches the same point again, and is equal to 365 days 5 hours 48 minutes 49·7 seconds; the odd time beyond the days rendering an extra day necessary in leap year to keep the calendar correct. The days are measured by the revolution of the earth on its axis, as shown by the apparent motion of the sun and stars. The time which elapses between the passage of the same star over the meridian of any place is a *sidereal* day, while that which is observed by the passage of the sun over the same meridian is called a *solar* day. But the sun having its own slow apparent motion in the ecliptic in the same direction as the revolution of the earth, the interval between one meridian transit of the sun and the next is longer than the simple revolution of the earth, as the latter has to overtake the sun, in the same way that the minute hand of a clock has to perform more than one revolution before it overtakes the hour hand. The result is, that a mean solar day is about 3 minutes 56 seconds longer than a sidereal day. But further, the apparent motion of the sun is not uniform, owing to the obliquity of the sun's path in respect to the earth's equator, and the unequal motion of the latter in its elliptical orbit. The result of this is, that the sun sometimes reaches the meridian before and sometimes after the precise instant when an equal motion would bring it there, the difference sometimes amounting to nearly a quarter of an hour, and constituting what is referred to as the *equation of time*. When noting the time, then, by the sun, whether through a transit telescope or by a sundial, we must apply the equation table as a correction to the time indicated. It is therefore more simple, and more convenient also, from there being constantly some star or other passing the meridian, to observe sidereal time, and apply the constant correction of $3^m\,55{\cdot}91^s$ of solar time to the time thus

observed. We thus obtain what is commonly called *mean time*. To all places on the earth's surface having the same longitude the time thus observed will be identical, as they have the same meridian with regard to the sun or star. It is usual, for convenience, within certain limits, to adopt the time of some fixed meridian as a standard. Thus, we speak in London of Greenwich mean time, signifying the time as observed at the Royal Observatory at Greenwich. This is the ultimate standard to which we reduce other observations, and by which we regulate our time-keepers.

Having thus cleared the way for a better appreciation of the results to be arrived at, we will return to the subject of clepsydras, referring now to those of more modern times than those we have before described.

Beckmann, in his "History of Inventions," dates the revival of clepsydræ to some time between 1643 and 1646; and Dr. Hutton asserts that in 1693 the first water clock was brought to Paris from Burgundy. He also says that Father Timothy, a Barnabite monk, had given the machine all the excellence it was capable of, by constructing it so as to make it go a month without replenishing, and to exhibit not only the hours on a dial plate, but also the sun's place, day of the month, and festivals throughout the year.

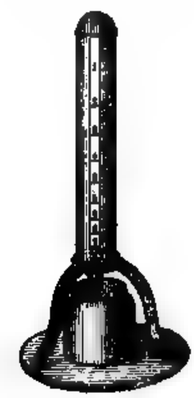
Fig. 10.

Fig. 10 represents a clepsydra of the 17th century, consisting of an oblong frame of wood, ABCD, to the upper part of which two cords, A *a* and B *b*, are fixed at their superior extremities and at their inferior are wound around the axis *a b* of the drum E. The drum is ɔwn in section at *fig.* 11, having seven

Fig. 11.

ter-tight metallic partitions, F *f*, G *g*, H *h*, K *k*, L *l*, and M *m*. If, now, the cord be und around the axis until the drum rises the top of the frame, and the drum be left obey the force of gravity, it will of course .d to fall, and the cord resisting this ten-ıcy will cause it to revolve rapidly as it ıcends. But if we introduce water into the ısel, it will be retained in certain parts of ı circumference by these partitions, and, ɜ side being thus heavier than the other, ; tendency to revolve will be counteracted, ł the drum will remain stationary. If now pierce a small hole near the bottom of each ł, the water will slowly ooze from it into ɔther, thus reducing the opposing weight of ter, and causing the drum slowly to re-.ve. The rate of motion being properly ;ulated by altering the size of the apertures, · axis will point out the hours on the side the frame; or a cord, *c d*, with a weight may be made to pass over a pulley attached an arbor bearing an index or hand to point · the hours on a circle properly engraved painted.

Fig. 12.



Another very simple form is shown in 12. It is merely a glass vessel which has

an orifice at the bottom, and is filled with as much water as will flow out in exactly twelve hours. If the whole height of the column be divided into 144 equal parts, 11 × 11 or 121 divisions from the bottom will be the place for the first hour mark, 10 × 10 or 100 will be the mark for the second hour, 9 × 9 or 81 the place for the third hour, and so on; which proportion is precisely the reverse of that according to which heavy bodies fall in free space by the sole force of gravity. The stem of a floating vessel, similar in form to an hydrometer, might be used to pass through an orifice in the cover, and indicate the hours by divisions on its stem. Again, vessels of a paraboloidal form have been constructed, from an orifice in the bottom of which water will issue in an equal stream, whatever the height of the column; or, more simply still, we may use a contrivance such as is shown in *fig.* 13.

Fig. 13.

It consists of a syphon attached to a float. By a well-known law in hydrostatics, the syphon will empty the vessel of the whole of the contained fluid, and the pressure exerted being equal to the difference in length between the shorter and longer leg remains always the same in consequence of the float falling as the water falls. Other clocks were also made, in which the weight of the water was made to keep a pendulum in motion; one of them is figured in "Machines Approuvées par l'Academie Française," published 150 years ago.

The construction of clepsydræ and of weight clocks went on contemporaneously for a long period, until the superior performance and convenience of the latter superseded the former. It may be interesting to mention that a water clock was among the contrivances of the boyhood of Sir Isaac Newton.

We have, in this rapid sketch of the earlier sundials and clepsydræ, we think, sufficiently demonstrated a fact of which every student of old contrivances must be convinced, namely, that our ancestors possessed great powers of mechanical combination. Of the actual advance they made, and of the precise condition of mechanical inventions which obtained in old times, we have sufficient record left to prove its high character; but when we remember that much must have been lost for want of means of record, and that in consequence the great majority of improvements and contrivances remained known to only a few, and perished with them, it will produce the wholesome reflection, that, with all our present knowledge and education, those who went before us are entitled to our reverence and respect for their talents and attainments.

At a future time we may probably take up the early history of clocks and portable timekeepers.

(*To be continued.*)

Erratum.—In this article in our last number, at page 47, col. i., line 11 from top, *for* "wire" *read* "cone."

"UT TENSIO SIC VIS."

It was the fashion, some two or three centuries ago, for philosophers who were engaged in a course of research, to publish from time to time the results at which they had arrived, or at which they saw good reason that they would arrive, in the form of anagrams. Thus, if they saw some discovery opening up before them, or some important practical or theoretical application of the knowledge they had obtained, they registered their own primary claims as the originators by publishing a series of letters composing some sentence (usually in the Latin tongue) expressive of some important fact which should be so new, or so connected with the subject, as to be sufficient to prove that the composer was acquainted with the matter in question. The letters being transposed or thrown together in confusion could not be translated by those who had not the key. The discovery thus remained hidden until sufficiently ripe for definite description, at the same time that sufficient publication took place to verify the owner's claim.

In the year 1658 Dr. Hooke, to whom horologists owe so much, and who is one of the most eminent Englishmen who have made horology their study, was especially engaged in the investigation of the laws of certain mechanical forces. He saw his way so clearly to a certain conclusion as to induce him to publish his discovery after the manner we have described, in the form *ceiiino sssttuv*. Hooke's investigations of the properties of the spring were of a very elaborate character. His experiments were performed on straight, spiral, and helical or

cylindrical springs, and he thoroughly investigated the laws of their action. After perfecting his details he published his discovery in full, and gave the key to his anagram in the words, "*Ut tensio sic vis;*" or, "As is the tension so is the power."

Hooke had thus enunciated an immutable law. He had found by reasoning and experiment that a metallic or other spring exerted more force in proportion as it was bent up. On this law he based his application of the pendulum spring to the balances of timekeepers; and his great point was, that a spring if rightly applied would insure the isochronism of the vibrations, that is to say, it would cause the balance to perform its oscillations in equal times, whether they should be long or short. This will be understood at once if we see that, as the spring was more bent up, it exerted more force, and so accelerated the motion of the balance to which it was attached.

Now this law, as we have just said, is a universal one. It applies to all kinds of springs, equally to the main-spring as it does to the balance spring; and further, equally to the springs of the locomotive engine or railway carriage as to the delicate wire with which we are all so well acquainted.

Hence it follows, that no spring can exert a perfectly equal force during the whole or during any portion of its action. The very quality which makes the spring so valuable when applied to an oscillating body, such as the balance, destroys its value when applied without adjustment to exert force in but one direction, as in the barrel spring. It may be possible to employ a spring of such a length, and to arrange it so, that the action being distributed over a great length, the inequality may become relatively less in smaller portions; but still the law remains. An approximation may become a closer one; but if we have a fundamental error opposing us under any circumstances, we can do nothing more than approximate by any use of similar conditions.

Now the motto at the head of this article "As is the tension, so is the power," is deeply important to us as watch manufacturers. Apart from the interesting fact that Hooke thus enunciated the principles of the pendulum spring, he also stated a rule that applies to the main spring, in whatever way it may be used. If we employ a going barrel, thus applying the force of the spring direct to the wheels, we must necessarily get more force exerted when the spring is wound to the top than when it is nearly down. We may take a long spring, or one giving many turns of the barrel, if we please, and isolate and use a part only of it by a properly contrived stop-work; but this is but an approximation, a mere compromise with a defect, instead of a removal of it.

Our old watchmakers, acute practical philosophers as they were, very soon saw the evil; and Hooke himself contrived a remedy, beautiful in its simplicity, and perfect in its action — which was speedily adopted as a characteristic feature especially in English timekeepers. The inverted cone, or *fusee* as we call it, is not only perfect in theory, but it is also perfect in practice. It admits of the most accurate adjustment, although very often not adjusted at all.

The simple reason why a return is now made to the going barrel — that exploded barbarism, strangled by our forefathers even at its birth—is two-fold:—first, the absurd minuteness of size fancied by a part of the public for their watches; and secondly, competition in price.

Let the aim of the British manufacturer be not cheapness, but excellence — not the caprice of fashion, but durability and usefulness. A cheap article involves low wages and hard work to the operative, while his employer gains but little. Superior workmanship commands a better remuneration to all parties, as well as being ever combined with a higher and nobler moral tone in all concerned.

HINTS ON THE PRESERVATION OF THE SIGHT.

To the Editor.

SIR,—A gentleman of high professional attainments, from whom I have received a degree of care and attention in the treatment of the sight for which I can never feel sufficiently grateful, has handed to me the following observations upon the preservation of the sight, which I consider would be highly acceptable to your readers; I therefore place them at your disposal, feeling convinced you will deem them worthy of a place in the Journal.

I am, &c. J. BREESE, Sen.

"All day the vacant eye without fatigue
Strays o'er the heavens and earth; but long intent
On microscopic arts, its vigour fails."

A clear head, distinct sight, and delicate touch are indispensable requisites for the satisfactory performance of the minute and intricate work in which watchmakers are engaged. The prudent workman, therefore, will observe every precaution calculated to secure the integrity of such valuable endowments for both present and future use. An

error of diet and regimen renders the head confused, the eye untrue, and the hand unsteady for a day or two at least, and so far loss is entailed. But, worse than this, repeated errors of the like kind may at last lead to the permanent impairment of the delicacy of both sight and touch, as well as a diminution of the energy with which the attention can be concentrated on the work in hand.

When by regularity of life the system is preserved in good condition, every object looked at is seen distinctly and handled with dexterity, while, the head being clear, the attention is concentrated without effort. The result is, that a great deal of work is got through in a short time and with little trouble. Moreover, no injurious strain has been laid on either the senses or the sensorium.

Work must not be persisted in too long: rest and relaxation ought to follow labour. If you encroach too much on the hours of to-day, the exhaustion of to-morrow will assuredly bring you to task. Leisure hours ought, so far as possible, to be relieved by exercise and amusement. The strain of a few days overwork is apt to be followed by collapse and an inordinate craving for stimulants. If this be yielded to, a debauch follows, and more is lost in every way, both directly and indirectly, than was gained by the previous too close application.

Passing from these general remarks, let us direct our attention more particularly to the sight. Here a preliminary observation suggests itself, viz., as to the sight of a young person about to be apprenticed. Considering that the watchmaking business is one in which the sight is especially called into requisition, it is obvious that it would be unwise to bring up to it a young person in whom that sense is in any way defective. In consequence of previous attacks of inflammation, the eyes may be so irritable that the sight, though not actually impaired, cannot be exercised to any purpose. Of such cases it is not necessary to say any thing—they speak for themselves to the point; but it is proper to remember, that eyes which have once suffered from inflammation, though they appear to have recovered, remain more than usually liable to become affected again from such exertion of the sight as would make little or no impression on sound eyes. We should therefore recommend a young person who has once suffered severely from any inflammation of the eyes not to become a watchmaker.

Again, an incapacity to keep up the exercise of sight on their work for any length of time is a very common complaint among watchmakers, jewellers, and others similarly employed. They may see very well for a few minutes at first, but the sight soon becomes confused. The complaint is owing to a diminished power of maintaining the adjustment necessary for viewing near and minute objects, and is brought on by the long continued straining of the apparatus within the eyes subservient to that purpose. Now young persons are sometimes already affected with this impairment of the power to maintain the adjustment of the eye for near objects (or *asthenopy*, as it is called) in various degrees. If the complaint presents itself in a marked degree, then of course there can be no question as to the unfitness of the person for the watchmaking business, or indeed any business requiring particular use of the sight. When the complaint exists in a slight degree, however, attention may not be much attracted to it at first, but as soon as the young person becomes seriously employed in fine work, he will probably find the defect interfere more and more with his occupation. In such a case, although convex spectacles of low power help the sight, it would be prudent for the person, before being too far committed, to relinquish the business altogether and at once, because the defect is one seldom entirely recovered from.

What we shall further say on the subject of the preservation of the sight we extract from a work by Professor Wharton Jones on the Defects of Sight.*

"Light is the agent through the medium of which external objects make their impressions on the sense of sight. We know by experience that a certain moderate intensity of illumination is that by which we can see objects at once most distinctly and most comfortably.

"Strong light dazzles and confuses the vision, at the same time that it pains the eyes, determines the blood to them, and excites a flow of tears. It is only after some time, perhaps, that the eyes recover themselves.

"The attempt to exercise the sight by too weak illumination, on the other hand, strains and fatigues the eyes in a manner scarcely less injurious.

"It is daylight alone which affords that degree and kind of illumination of objects which we find most agreeable to the eyes, and by which we can longest and with the least fatigue exercise the sight. Artificial lights of all kinds are much inferior. The mild diffusion of the light of day, with the

* London, John Churchill, 1856.

necessary intensity, uniformity, and steadiness, can be but imperfectly imitated in artificial light, which is usually either too concentrated or too weak and unequal and flickering in comparison. And then in respect to quality, what a difference is there to the eyes between working in the clear colourless light of day and the dingy red and yellow light obtained by combustion!

"Our own natural feelings — a good monitor to be guided by in regulating the quantity and quality of the light to which the eyes are exposed—warn us that work at all trying to the sight is best done by day. Work requiring least exertion of vision may be done by artificial light.

"When we use artificial light for working by, it should be, as far as possible, sufficiently bright without being dazzling. The light concentrated by glass globes filled with water, as used by jewellery, are by no means favourable to the eyesight; they should be used, therefore, as little as possible."

* * * *

"When the health is naturally good, and care is taken of it, and attention is paid to the conditions under which the sight may be most safely exerted, the eyes, though much tried, whether by daylight or by artificial light, will continue to stand exertion very well. Much exertion of the eyes operates more prejudicially to the sight under some circumstances than under others. Exertion of the sight, for example, is especially prejudicial immediately after a full meal, after the use of spirituous drinks, while smoking, when the body is in a recumbent or stooping position, when dressed in tight clothing, in close ill-ventilated apartments lighted with gas, after bodily fatigue, during mental distress, late at nights when sleepy, after a sleepless night, while the bowels are much confined, &c."

* * * *

We have above referred to a defect of sight named *asthenopy.* The following are a few more details on the subject:—

"Asthenopy is an incapacity to exercise the sight on near and minute objects for any length of time. The patient is able at first to see objects quite distinctly, but the vision soon grows confused. The eyes at the same time, perhaps, become tired and painful—the pain extending to the head.

"If the eyes are closed and rest given to them for a few minutes, the sight may be again exercised, but in a short time the eyes will become fatigued and the vision confused as before.

"*Vision for distant* objects is not disturbed, *and by the use of* convex glasses the *exercise of sight* on near objects may be *much assisted.*

"A very frequent cause of asthenopy is pure over-exertion of the eyes, as in students, artists, clerks, watchmakers, &c., especially by artificial light, together with want of sleep, want of exercise in the open air, and other debilitating influences.

"The prospect of a complete cure of asthenopy is, on the whole, unfavourable, especially if the complaint is of long standing; less unfavourable, provided what appears to be the exciting cause admits of removal. Asthenopy, though it has become confirmed, is not likely to end in blindness.

"The first thing in the way of arresting the complaint is the avoidance or removal of any cause which may appear to be in operation, such as over-use of the eyes, and other causes above enumerated.

"Rest to the eyes, the occasional application to them of cold water, good diet, exercise, country air, sea bathing, and the like, must in general constitute a leading part of the treatment of asthenopy.

"When the patient requires to employ his eyes on near objects, he has no other resource than to use convex glasses, which in some cases must be of the very lowest power only; but it would be advisable for the patient, if his occupation requires much use of the eyes, to change it, if possible, for one of an opposite kind."

PRESENTATION TO MR. CHARLES DICKENS.—On Saturday evening, the inhabitants of Coventry entertained Mr. Charles Dickens at a public dinner, held at the Castle hotel, in that city, at which they presented him with a valuable gold watch, of their own manufacture, bearing the following inscription:—"Presented to Charles Dickens, Esq., by his friends at Coventry, in testimony of his kindness to them, and his eminent services to the interests of humanity." In December last year Mr. Dickens favoured the Mechanics' Institute with a gratuitous reading of his "Christmas Carol," and it was in acknowledgment of this service that the above presentation was made. Mr. Charles Wren Hoskins occupied the chair, and there were present many of the most influential inhabitants of Coventry. The presentation was made after dinner by the chairman in an able speech, highly eulogistic of Mr. Dickens's eminent services to his country by the development of his literary genius. Mr. Dickens briefly replied. He assured them, the watch they had presented to him would be deeply prized by him, and should be his companion in all his sedentary workings at home, and his restless wanderings abroad; it should never be absent from his side, to count, he hoped, the hours of many laborious days. When he had done with time and with its measurement, that watch should belong to his children; and as he had seven boys, and as they had all of them begun to serve their country in various ways, or were to be trained to do so, and as they had begun to elect into what distant regions they should seek their fortunes, he had great pleasure in imagining that it was not only possible, but very probable, its little voice might be heard years hence telling the time in some unfounded city in the wilds of Australia, or, who knew, it might be in Coventry-street, Japan. (Laughter and cheers.)

PLATES ILLUSTRATIVE OF THE PRINCIPLES OF MR. HARRISON'S TIME-KEEPER.

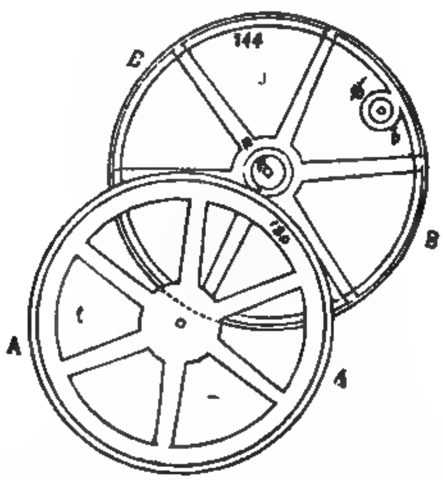
(*Continued from page* 51.)

FIG. 3.

A A is the First Wheel, and *a a a a* is a Section of it. *b b b* is a Section of the Fusee. B B is the outer Diameter of a Ratchet which is fixed to the inside of the Fusee, and the inner Circle C C is its inner Diameter, and it has 55 Teeth in it. *d d d d* is what I call the perpetual Ratchet, of which *c c c c* is a section ; there is a Ratchet with 75 Teeth in it on that part marked *f f*, this is also shewn in Figure 13 by the circle *e e*, and this perpetual Ratchet is to carry the Barrel D D, which Barrel contains the secondary Main-spring, and will be in the inside of the Fusee at *g g*, and at that part of the First Wheel *h h* the Inner End of this Spring is to act, as that part *h h* will be its Arbor. The dotted lines E represent the Grooves in the Fusee. The dotted lines *l l* represent the Upper Plate. The dotted lines *m m* represent the Pillar Plate. The dotted lines *n n* represent the Cock which carries the lower end of the Arbor of the First Wheel. This Cock is also represented in Figure 13 at *d d d d*. The Ratchet *e e* in Figure 13 has two Clicks, whose centres are at *f f*, and *g g* are the Springs which act at these Clicks. In Figure 14, *b b* represents the First Wheel with 96 Teeth, acting in a Pinion of 21 at *c*.

FIG. 4.

The Section of the Third Wheel.



A A represents the Second Wheel acting in a Pinion at *a*. B B represents the Third Wheel, which is concave, and acts in a Pinion at *b*. The Second Wheel is described in Figure 14 by the Circle *d d*, and acts in a Pinion of 18 at *e*. The Third Wheel is represented in Figure 14 *by the Circle f f, acting* in a Pinion of 16 at *g*.

Note,—The Third Wheel is larger than is represented at Figure 14, and has 144 Teeth, *and the Second Wheel has 120* Teeth.

TABLES FOR FACILITATING THE RATING OF CHRONOMETERS AND WATCHES, &c., IN DIFFERENT TEMPERATURES OR POSITIONS.

(*Continued from p.* 52.)

TABLE II.—Division I.

	0·5s	1s	2s	3	4s	5s	6s	7s	8s	9s	10s
	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.
A	12·0	24·0	48·0	72·0	96·0	120·0	144·0	168·0	192·0	216·0	240·0
B	11·08	22·15	44·31	66·46	88·61	110·77	132·92	155·08	177·23	199·38	221·54
C	10·28	20·57	41·14	61·71	82·28	102·85	123·42	144·00	164·57	185·14	205·71
D	9·60	19·20	38·40	57·60	76·80	96·00	115·20	134·40	153·60	172·80	192·00
E	9·00	18·00	36·00	54·00	72·00	90·00	108·00	126.00	144·00	162·00	180·00
F	8·47	16·94	33·88	50·82	67·76	84·70	101·65	118·58	135·52	152·47	169·41
G	8·00	16·00	32·00	48·00	64·00	80·00	96·00	112·00	128·00	144·00	160·00
H	7·58	15·16	30·32	45·47	60·63	75·79	90·94	106·11	121·26	136·42	151·58
I	7·20	14·40	28·80	43·20	57·60	72·00	86·40	100·80	115·20	129·60	144·00
K	6·86	13·71	27·43	41·14	54·86	68·57	82·29	96·00	109·71	123·43	137·14
L	6·55	13·11	26·22	39·33	52·44	65·55	78·66	91·77	104·88	118·00	131·11
M	6·26	12·52	25·05	37·57	50·09	62·61	75·13	87·65	100·17	112·68	125·21
N	6·00	12·00	24·00	36·00	48·00	60·00	72·00	84·00	96·00	108·00	120·00
O	5·76	11·52	23·04	34·56	46·08	57·60	69·12	80·64	92·16	103·68	115·20
P	5·54	11·08	22·15	33·23	44·31	55·38	66·46	77·54	88·62	99·69	110·77
Q	5·33	10·66	21·33	32·00	42·66	53·33	64·00	74·66	85·33	96·00	106·66
R	5·14	10·29	20·57	30·86	41·14	51·43	61·71	72·00	82·29	92·57	102·86
S	4·97	9·93	19·86	29·79	39·72	49·65	59·31	69·52	79·31	89·28	99·31
T	4·80	9·60	19·20	28·80	38·40	48·00	57·60	67·20	76·80	86·40	96·00
U	4·64	9·30	18·58	27·87	37·16	46·45	55·74	65·03	74·32	83·61	92·90
W	4·50	9·00	18·00	27·00	36·00	45·00	54·00	63·00	72·00	81·00	90·00
X	4·36	8·73	17·45	26·18	34·91	43·64	52·36	61·09	69·82	78·54	87·27
Y	4·23	8·47	16·94	25·41	33·88	42·35	50·82	59·29	67·76	76·23	84·12
Z	4·11	8·23	16·45	24·68	32·91	41·14	49·37	57·60	65·83	74·06	82·28

Explanation.

This Table, as already intimated, is to be used in connection with Table I. at p. 52.

The figures in the top row of this Table, from 0·5s to 10s, represent the gain or loss, in seconds, of the watch or clock during the time it has been under trial, and which time is here represented by the peculiar kind of letter which is to be found from Table I., as previously explained; then, under the heading of the proper gain or loss for such time, *and in the row corresponding* with the letter so found, will be the *daily* rate (or gain or loss) in seconds and decimal parts of a second.

If it be required to convert the seconds into minutes, cut off the last figure before the decimal point, divide the preceding part of the number by 6, placing the remainder, if any, before the figure you have cut off. Thus, 267·54 : divide 26 by 6, gives 4 and 2 over, which will be 6 minutes 27 seconds and 54 hundredths. Or, again, 125·21 : cut off 5, and divide 12 by 6, gives you 2 minutes 5 seconds and 21 hundredths as the result.

TABLE II.—DIVISION II.

	0·5s	1s	2s	3s	4s	5s	6s	7s	8s	9s	10s
	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.
A	4·00	8·00	16·00	24·00	32·00	40·00	48·00	56·00	64·00	72·00	80·00
B	3·89	7·78	15·57	23·35	31·14	38·92	46·43	54·49	62·27	70·05	77·84
C	3·79	7·58	15·16	22·74	30·32	37·89	45·47	53·05	60·63	68·21	75·79
D	3·69	7·38	14·77	22·15	29·54	36·92	44 30	51·69	59·08	66·46	73·85
E	3·60	7·20	14·40	21·60	28·80	36·00	43·20	50·40	57·60	64·80	72·00
F	3·51	7·02	14·05	21·07	28·10	35·12	42·15	49·17	56·20	63·22	70·24
G	3·43	6·85	13·71	20·57	27·43	34·29	41·14	48·00	54·85	41·71	68·57
H	3·35	6·70	13·39	20·07	26·79	33·49	40·19	46·88	53·58	60·28	66·98
I	3·27	6·54	13·09	19·64	26·18	32·73	39·27	45·82	52·36	58·91	65·45
K	3·20	6·40	12·80	19·20	25·60	32·20	38·40	44·80	51·20	57·60	64·00
L	3·13	6·26	12·52	18·78	25·04	31·30	37·56	43·83	50·09	56·35	62·61
M	3·06	6·13	12·25	18·38	24·51	30·64	36·76	42·89	49·02	55·19	61·28
N	3·00	6·00	12·00	18·00	24·00	30·00	36·00	42·00	48·00	54·00	60·00
O	2·94	5·88	11·75	17·63	23·51	29·39	35·26	41·14	47·02	52·90	58·79
P	2·88	5·76	11·52	17·28	23·04	28·80	34·56	40·32	46·08	51·84	57·60
Q	2·82	5·65	11·29	16·99	22·59	28·23	33·88	39·30	45·18	50·85	56·47
R	2·77	5·54	11·08	16·61	22·15	27·69	33·23	38·77	44·30	49·85	55·38
S	2·72	5·43	10·87	16·30	21·74	25·28	32·41	38·04	43·40	48·96	54·34
T	2·67	5·34	10·67	16·00	21·34	26·67	32·00	37·34	42·67	48·00	53·34
U	2·62	5·24	10·47	15·71	20·77	26·18	31·42	36·54	41·89	47·09	52·36
W	2·57	5·14	10·28	15·43	20·57	25·71	30·86	36·00	41·14	46·28	51·43
X	2·42	4·84	9·84	14·53	18·84	24·21	28·06	33·89	48·26	43·05	48·42
Y	2·48	4·96	9·93	14·89	19·86	24·83	29·79	34·76	39·72	44·69	49·65
Z	2·47	4·89	9·77	14·64	19·52	24·41	29·29	34·17	39·05	43·32	48·81

Biographical Sketches of Eminent Horologists.

DR. DERHAM.

William Derham, an eminent English divine, but who deserves a notice in our Journal as one of the early writers on practical horology, was born at Stourton, near Worcester, in 1657. He received his education at Bluckley in the same county, but was removed to Trinity College, Oxford, in 1675, where he took his degree of Bachelor of Arts in 1678, and so distinguished himself that Dr. Bathurst strongly recommended him to the notice of Dr. Seth Ward, Bishop of Salisbury. Through the influence of that prelate he became (as soon as he had taken orders) in 1681, chaplain to Lady Dowager Grey of Warke. In 1682 he was presented to the vicarage of Wargrave in Berkshire, and in 1689 to the rectory of Upminster in Essex. In this place he applied himself most sedulously to the study of nature, natural philosophy, and the mathematics; his attainments in which caused him to be chosen a Fellow of the Royal Society. Of that society he proved one of its most industrious and useful members, supplying it for a series of years with many curious and valuable papers, which appear in the Philosophical Transactions. It is to him that we are indebted for "The Artificial Clockmaker; a treatise of watch and clock work, showing the art of calculating numbers for all sorts of movements; the way to alter clock-work, to make chimes and set them to musical notes, and to calculate and correct the motions of pendulums," London, 12mo. This work was favourably received, and

TABLE II.—DIVISION III.

	0·5s	1s	2s	3s	4s	5s	6s	7s	8s	9s	10s
	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.	Sec.
A	2·40	4·80	9·60	14·40	19·20	24·00	28·80	33·60	38·40	43·20	48·00
B	2·36	4·72	9·44	14·16	18·88	23·61	28·33	33·05	37·77	42·49	47·21
C	2·32	4·65	9·29	13·93	18·58	23·23	26·74	32·52	37·16	41·81	46·45
D	2·29	4·57	9·14	13·71	18·29	22·86	27·43	32·00	36·57	41·14	45·71
E	2·25	4·50	9·00	13·50	18·00	22·50	27·00	31·50	36·00	40·50	45·00
F	2·21	4·43	8·86	13·28	17·72	22·15	26·58	31·01	85·45	39·88	44·31
G	2·18	4·37	8·73	13·09	17·45	21·81	26·18	30·54	34·91	39·27	43·64
H	2·15	4·29	8·60	12·90	17·19	21·49	25·79	30·09	31·40	38·68	42·99
I	2·12	4·24	8·47	12·71	16·94	21·18	25·41	29·65	33·88	38·12	42·35
K	2·09	4·17	8·35	12·52	16·69	20·87	25·04	29·22	33·39	37·57	41·74
L	2·06	4·11	8·23	12·34	16·46	20·57	24·69	28·80	32·91	37·04	41·14
M	2·03	4·06	8·11	12·17	16·37	20·28	24·34	28·39	32·45	36·51	40·57
N	2·00	4·00	8·00	12·00	16·00	20·00	24·00	28·00	32·00	36·00	40·00
O	1·97	3·94	7·89	11·83	15·78	19·73	23·67	27·62	31·56	35·48	39·46
P	1·95	3·89	7·78	11·67	15·35	19·46	23·38	27·24	31·13	35·03	38·92
Q	1·92	3·84	7·68	11·52	15·36	19·20	23·04	26·88	30·72	34·56	38·40
R	1·89	3·79	7·58	11·37	15·16	18·95	22·74	26·53	30·32	34·11	37·89
S	1·87	3·74	7·48	11·22	14·96	18·70	22·44	26·18	29·92	33·66	37·40
T	1·85	3·69	7·38	11·08	14·77	18·40	22·15	25·85	29·54	33·23	36·92
U	1·82	3·64	7·29	10·94	14·58	18·23	21·87	25·52	29·15	30·28	36·45
W	1·80	3·60	7·20	10·80	14·40	18·00	21·60	25·20	28·80	32·40	36·00
X	1·78	3·56	7·11	10·67	14·22	17·78	21·33	24·89	28·44	32·00	35·55
Y	1·76	3·51	7·02	10·54	14·05	17·56	21·07	24·59	28·10	31·61	35·12
Z	1·73	3·47	6·94	10·41	13·52	17·35	20·82	24·29	27·76	31·23	34·70

passed through several editions, and certainly was at the time it appeared a very useful addition to horological literature. In 1711 and 1712 he discharged the office of preacher of Mr. Boyle's Lecture, and in 1713 published the sermons. In 1714 he published "Astro-theology," and "A Survey of the Heavens," in 8vo, with copperplates, both which works possess great merit. On the accesion of George I he was made chaplain to his Majesty, and in 1716 was appointed a canon of Westminster. In 1730 he received from the University of Oxford the degree of Doctor of Divinity. In the same year he published his "Christo-theology," 8vo. Besides works of his own compilation, he added notes to Albin's Natural History of Birds and English Insects; revised "*Miscellanea Curiosa*," in 3 vols, 1726; published "*Joannis Raii Synopsis Methodica Avium et Piscium, &c.*" 8vo., 1713; "Philosophical Letters between the late learned Mr. Ray and several other ingenious correspondents," 8vo, 1718; also new editions of other pieces of that celebrated naturalist, with additions from his manuscripts. We are also indebted to Dr. Derham for the publication of the "Philosophical Experiments and Observations of Dr. Robert Hooke, F. R. S.," (another of the great contributors to the science of horology), besides those of other eminent virtuosi of his time.

Dr. Derham died at Upminster in 1735, at the age of 78, after a most active and laborious life, devoted to the instruction and improvement of his fellow men, and affording a striking proof of how much valuable information on a great variety of subjects may be disseminated by the exertions of one individual during the short period of human existence.

TABLE II.—DIVISION IV.

counteract its great irregularities of force; and consequently its pull is so variable, that the balance is driven by it from half a circle of vibration when wound up half a turn of the key, to a circle and a half when fully wound up. Neither is there any stop work to prevent the strain upon the spring when wound up.

"The frames are so plain that little need be said about them, except that, while studying economy, the designer might as well have dispensed with the third wheel bar at the back of the pillar plate.

"The wheels and pinions are of the roughest make; the former being merely stoned across and coarsely electro-gilt. They are mounted by burnishing or riveting them on to brass collets which are driven on to the pinion arbors, the collets being ungilt.

"The pinions, both in quality and pivoting, are very inferior, and finishing is entirely omitted.

"The jewelling is of soft stones—both stone and setting of a character such as I should not like to trust myself to describe; suffice it to say, that they exceed in roughness and unsoundness the worst I ever saw in English work.

"The holes, I have good reason to believe, were made by boys in England, and I think I could point to the very shop in which they were produced.

"The scape wheel and pallets are, without doubt, as well as the dial (which has a sunk seconds), of the lowest class of Liverpool manufacture.

"The hands are decidedly Birmingham.

"The fittings—namely, the click, ratchet, and spring for the main-spring, are polished on the surface; in other respects they are as rough as they left the stamping press.

"The watch, I should state, is sprung under the balance, having a stud of needless length screwed to the plate.

"To compare this watch with any thing made either in England or Switzerland by decent makers, is out of the question. How far a home-made case and pair of frames, fitted with details of the coarsest and cheapest foreign production, can entitle it to nationality, I think we must cross the Atlantic to learn.

"In using the terms *finished* and *rough*, I would explain, that the pinions, for instance, are, I verily believe, in a rougher and worse state in this finished watch than when they first left the pinion maker.

"I forbear making any general remarks, considering that is more in your province than in mine.

"*I am, Sir, your's respectfully,*

"VERTICAL."

It is at all times an ungracious task to find fault, and particularly so with first attempts, for which fair allowances should always be made; but as the establishment of a Watch Manufactory was announced as not only in active operation, but that it was producing articles of first-rate quality, such as were not only to put every other manufacture of the same article into the shade, but to drive the manufacturer entirely out of the market, we felt a great desire to examine one of these grand national productions. We have done so—we have seen this thing dissected, and truth obliges us to declare, that our correspondent's report is by no means exaggerated; and that if an abandonment of all the acknowledged principles of good time-keeping, and of improvements which long experience has approved and adopted, and a return to rudimentary forms and unscientific principles, be the indications of a great national improvement in the practice of horology, then may this specimen of American talent claim to be its representative.

We do not make these remarks lightly. The watch has not only been examined by one person, but many respectable persons in the different branches have in our presence pointed out the very spot where the individual parts have been made, and named the persons by whom such articles are made for exportation to the States; and we know that every practical and experienced workman possesses that intuitive knowledge of the style of work of his fellows in the same line, which, with almost unerring certainty, enables him to point out the makers of the different articles in his peculiar department, if he has but once seen work from the same hands. This is a fact which, although difficult to account for, we are sure will be acknowledged by all working men—and it is of this knowledge that we have availed ourselves.—ED.

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIME-KEEPERS.

BY B. WOODCROFT, ESQ.

(*Continued from page* 57.)

1704, May 1.—No. 371.

FACIO, NICHOLAS; DEBANFRE, PETER; and DEBANFRE, JACOB.—"An art of working pretious or more common stones (whether naturall or artificial), christal or glass, and certain other matters different from metals, so that they may be employed and made vse of in clockwork or watchwork and many other engins, not for ornament only, but as an internal and

vsefull part of the work or engine itselfe, in such manners as have not heretofore been vsed."

[No Specification enrolled. Letters Patent printed, 3*d*.]

1716, July 31.—No. 407.

EVANS, Robert.—" Two circular movements, performed by two chaines" (which the patentee calls his "endlesse chaines"), "of great vse in jackwork," to which movements he hath added "a new circular spring, which is so contrived as to force the jack round, even during the winding vp, by a contrary motion; the same movements "will be of the same vse in clockwork, and in some sort of water works."

[No Specification enrolled.]

1732, January 11.—No. 535.

ROWNING, John.— A new-invented clock, which with only one set of wheels besides the watch part may be set in the comon course of its motion to strike the hours only, or the hours and quarters, or the past hours with each quarter, or to be silent, and also, by pulling a string, repeats both hour and quarter."

[No Specification enrolled. Letters Patent printed, 4*d*.]

1749, January 31.—No. 639.

CARTWRIGHT, Benjamin.—1. Relates to candle snuffers.

2. A secret spring to secure a watch in the pocket or to the side. The spring is fastened to the wearer's dress by a string or two small screws, and the watch chain falls into or is attached to a loop, which by an easy pressure locks so as to prevent the watch from falling out of the pocket or being snatched from the side. The loop may be easily opened again by touching a small knobb or button.

[Specification printed, price 3*d*.]

1755, March 1.—No. 698.

BOSLEY, Joseph.—1. Increasing the number of teeth in the small pinions throughout the whole movement of repeating and other watches. The pinions consequently become larger, and the wheel that leads them goes farther from the centre. A wheel and pinion more than commonly used is necessary to prevent the watch going down before the usual time, but each wheel leading its pinion so much farther from the centre lessens the friction. The balance wheel goes the contrary way. The inventor expressly avoids confining himself to any particular numbers in the increase of the teeth.

2. A new invented slide, which slide has no wheel attached to it. The index turns upon a brass sockett, and points to an arch of a circle, divided, with the word *faster* on one end, and the word *slower* on the other; and the index may be made with a cock to keep it down, or with screws, or with springs."

[Printed, 4*d*. See Rolls Chapel Reports, 6th Report, p. 157.]

1761, June 25.—No. 763.

SANDERSON, George.—" Tools and engines for the preparing, stamping, fixing, turning, cutting, and finishing" parts of a watch. 1. A universal engine lathe, consisting of a mandril on which the several parts are to be fixed, in order to be cut or turned by means of the screw, which is cut at the end, in order to fix on the brass collets that are intended to hold the parts to be worked; a dividing plate, on which is fixed the numbers made use of for cutting the cock, pottance wheels, or any other part of a watch. This mandril in made hollow about half way through from the screw, in which works a small arbor up and down by means of a spiral spring lodged in the bottom, which always presses the end of the screw forward. There are also four cutting frames, two of which carry circular cutters, and the other two have square holes, through which a piece of steel is put and fastened by a screw, the end of this steel being fashioned according to the form of the thing to be turned. These cutting frames can be turned up and applied towards the screw end of the mandril, and their position can be altered and adjusted.

2. A screw-press, in the bottom of which is placed a die with a number of fixed centres, to operate as centre punches, for the accurate dispatch of marking the pillar plates for drilling.

3. A tool for cutting screws with a circular cutter. A large screw has a hole through it lengthwise, and the wire to be cut is passed through and fastened in this. The cutter is then sunk as deep on the wire as necessary; this being done at a notch in one of the poppet heads of the frame to which the engine is attached. The screw is then moved forward, and it carries with it the wire and causes it to be cut.

4. A brass or iron collet, with three broad headed screws in it, under which are to be placed the watch-plates after they are hardened and filed flat on one side, in order that a cutting frame may drop upon it and strike a circle intended to adjust the thickness, after which the circle is to be filed out. The above may be used for the cocks, wheel, cap, or any part of a watch where an exact thickness is required.

5. A collet to turn the pillar plates upon after being filed of a thickness, which is done by turning one of the frames up against it, to turn off the edge and bring it to size.

6. A collet to turn the upper plates upon, the square pottance holes being cut before these are turned.

7. A piece of iron, like a sugar loaf, to be screwed up tight against the plates by means of a screw on one of the poppet heads, to be used for making the plates round, by turning or cutting off the corners.

8. A steel pottance die. A hole is drilled through the die, which is intended to strike the pottances back in case they stick in the die.

9. A pattern for the pottance brass to be cast by. The tails have to be sawed through, being intended for two.

10. A cutting frame for crossing watches, which is to be substituted for any of the four cutting frames mentioned above. The crosses are cut by an oval cutter.

[Printed, 7*d*.]

The Swiss Federal Council has informed the different Chambers of Commerce that the Watch and Clockmakers at Chaux-de-Fonds are making preparations to send a deputation of their trade direct to Persia, China, and Japan; and the various chambers are invited to take part in the movement.

TO CORRESPONDENTS.

♈—We believe you will get the article after which you enquire at Müller's Tool Warehouse in King Street, Soho.

E. B.—Your Answer to the Question by Horologiorum Faber, in No. 4, has been received, and will be inserted if you will favour us with the steps of the process by which you arrive at the results in your communication.

A Learner asks us to give him a train for turning a hand round in 365 days, for the purpose of shewing the day of the month for the whole year, and the mode of moving a hand $\frac{1}{365}$ part of the circle each 24 hours.

We submit the following as applicable to the purpose:—Concentric with the circle on which the 365 divisions are to be made, place a wheel and socket, in any convenient mode so that it is free to turn round with its socket; to which latter a hand can be affixed to mark the divisions. Let this wheel have 73 teeth cut on its edge, suitable for a single-threaded screw or worm to work in as a driver; on the axis of this screw place a star wheel of 5 teeth, with a spring and jumper, to retain it in the required position for pointing exactly to the divisions on the dial plate. Let the position of the star wheel be such that one of its teeth can be acted upon by a pin placed in a wheel revolving once in 24 hours, so that one tooth of the star wheel shall be shifted at each contact of the pin — thus causing the screw to make $\frac{1}{5}$ of a revolution per day, and as $\frac{1}{5}$ of $\frac{1}{73}$ is equal to $\frac{1}{365}$ the wheel of 73 with its socket and hand will be moved one 365th part of a circle every day.

Declinations of the following **Stars**, and Times at which they are on the Meridian at Greenwich, for January, 1859.

Name of Stars.	Day of Mon.	Dec. North °	′	″	Time of passing the Meridian. h	m	s
α Tauri (*Aldebaran.*)	1	16	13	29·9	9	43	49·91 p.m
	11	16	13	29·7	9	4	30·76 „
	21	16	13	29·4	8	25	11·58 „
	31	16	13	29·1	7	45	52·36 „
α Aurigæ (*Capella.*)	1	45	51	11·4	10	22	11·03 p.m
	11	45	51	12·7	9	42	51·90 „
	21	45	51	13·9	9	3	32·71 „
	31	45	51	14·9	8	24	13·48 „
		Dec. South					
β Orionis (*Rigel.*)	1	8	21	59·1	10	23	39·16 p.m
	11	8	21	60·6	9	44	20·02 „
	21	8	21	62·0	9	5	0·87 „
	31	8	21	63·2	8	25	41·66 „
α Canis Majoris (*Sirius.*)	1	16	31	28·2	11	54	34·75 p.m
	11	16	31	30·5	11	15	15·69 „
	21	16	31	32·7	10	35	56·60 „
	31	16	31	34·7	9	56	37·45 „

EQUATION OF TIME TABLE

For January, 1859.

Day of the Week.	Day of Mnth.	At Apparent Noon Equation of Time to be *added* to Apparent Time. m.	s.	Difference for One Hour. s.	At Mean Noon. Equation of Time to be *subtracted* from Mean Time. m.	s.
Sat. ..	1	3	43·84	1·182	3	43·77
Sun. ..	2	4	12·22	1·168	4	12·14
Mon...	3	4	40·26	1·152	4	40·17
Tues..	4	5	7·92	1·135	5	7·82
Wed ..	5	5	35·17	1·117	5	35·07
Thurs.	6	6	1·97	1·097	6	1·86
Fri. ..	7	6	28·30	1·076	6	28·18
Sat. ..	8	6	54·11	1·053	6	53·99
Sun. ..	9	7	19·39	1·029	7	19·26
Mon...	10	7	44·10	1·005	7	43·97
Tues..	11	8	8·22	0·980	8	8·09
Wed ..	12	8	31·74	0·953	8	31.61
Thurs.	13	8	54·62	0·926	8	54·49
Fri. ..	14	9	16·84	0·898	9	16·70
Sat. ..	15	9	38·38	0·870	9	38·24
Sun. ..	16	9	59·24	0·840	9	59·10
Mon...	17	10	19·41	0·810	10	19·27
Tues..	18	10	38·85	0·780	10	38·71
Wed...	19	10	57·56	0·749	10	57·42
Thurs.	20	11	15·54	0·718	11	15·40
Fri. ..	21	11	32·77	0·687	11	32·64
Sat. ..	22	11	49·24	0·655	11	49·11
Sun. ..	23	12	4·96	0·623	12	4·83
Mon...	24	12	19·90	0·590	12	19·78
Tues..	25	12	34·06	0·558	12	33·95
Wed ..	26	12	47·45	0 525	12	47·34
Thurs.	27	13	0·05	0·492	12	59·94
Fri. ..	28	13	11·86	0·458	13	11·76
Sat. ..	29	13	22·86	0·425	13	22·76
Sun. ..	30	13	33·05	0·391	13	32·96
Mon...	31	13	42·43	0·357	13	42·35

*** *All Communications for this Journal should be addressed to* "*The* Editor," *at the Office*, 35, Northampton Square, Clerkenwell.

N.B. All Advertisements to be inserted in the Journal, must be received before the 25th of the month.

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THE PROPOSED EXHIBITION OF 1861.

We deem it our duty to draw the attention of our readers to the proposals which have been made for another grand Industrial Exhibition in 1861.

In another part of this number of our Journal will be found copies of two circulars issued by the Council of the Society of Arts in reference to this subject, and we also insert a letter from a correspondent in relation to it.

The present state of the question seems to be as follows. The Council of the Society of Arts, from whom emanated the idea of the Exhibition of 1851, have not lost sight of the original form of that idea, which was, to establish decennial expositions of works of industry, which might form epochs capable of comparison and reference. It was thought that these intellectual landmarks would prove useful in many ways—chiefly in the immediate improvement of manufactures, but also as a sort of registration of improvements. We know the results of this idea in the Exhibition of 1851, which, as a collection, far exceeded the most sanguine expectations of its founders. It was truly, in every sense of the word, *unique*. Never before had nation vied with nation in the arts of peace in a fair and open field. But the very vastness of the result, the very success of the scheme as an *Exhibition*, was a reason why it failed as a true gauge of power and merit. So immense a collection could be grasped by no individual mind. The officials engaged, new to their work, could not be expected to arrive at perfect conclusions with respect to the duties they had to perform. In the bestowal of rewards the inevitable jealousy of rival manufacturers rendered the decisions unsatisfactory, and led to unpleasant results (to which we need not now more particularly allude) in at any rate *one* particular class of manufacture.

We are not among the number of those who think that the Exhibition of 1851 is so unapproachable in splendour and magnitude as to make it undesirable to repeat the experiment. We do not associate display with usefulness ; and we very much question, whether more substantial improvements might not have resulted from an Exhibition which, although not so glittering, might have been more perfect in its details, and therefore more satisfactory in its effects.

Mindful of their original intention, therefore, the promoters of the Exhibition of 1851 desire to establish one in every ten years. They desire that the next, if not so vast, shall be more perfect than its predecessor, and therefore, as will be seen by their circular, they wish to elicit the ideas of those who may have given thought to the matter ; and they hope that the experience which has been gained may prove valuable in enabling the managers to avoid what there was of error in the past.

It will be seen that the plan as at present sketched differs in important particulars from the details of the first one. A classification into *species* is to be adopted, instead of the former one into *countries* ; and still more important is the proposition, that the Exposition should be of *selected* works. We foresee considerable labour and difficulty attending upon the latter condition ; but, if possible, it would undoubtedly be better to exclude what is common-place and crude.

We would especially call the attention of the Watch and Clock trade to the subject for this reason :—we believe we were not efficiently represented in the last Exhibition. We do not say that practical men did not exhibit, or that the specimens they exhibited were unsatisfactory in themselves ; but we do say, that the English Watch and Clock making department of the Exhibition of 1851 did not give a true or an adequate idea of the state of the manufacture in this country. We need not further allude to the unpleasant conclusion of the Exhibition in relation to our own department, except to point out that we have the remedy in our own hands with respect to the future. It ought, and it must be

so arranged, that suspicion will have no hold for its fell suggestions. We must be adequately represented; and if we are not, it will be our own fault.

We can only say for ourselves (and, we think, for many more), that we wish all success to the proposed Exhibition in 1861, and we invite from our correspondents the fullest expression of opinion upon the subject.

We have the pleasure of announcing, on the part of the Council of the BRITISH HOROLOGICAL INSTITUTE, that a room has been prepared for the reception of Models and Specimens illustrative of the art. Several models have already been presented to the Institute. Among them is one of Ferguson's Mechanical Paradox, kindly sent by Mr. Lowe, of Manchester; that gentleman's attention having been arrested by the original letter of Ferguson's which appeared in our Fourth Number.

The Council have also received a copy of an Engraving of Improvements in the Detached Lever Escapement by Mr. J. F. COLE, from that gentleman, who has given the name of the "Resilient Lever Escapement" to this particular form.

We insert in the present number a general description, by Mr. HARTNUP, of the Liverpool Observatory, of the method whereby a number of pendulums may be made to keep time together by galvanic agency. The subject is an important one, and we hope to be able to furnish the details of the method pursued at Liverpool,—with engravings, if possible. In the meanwhile we would call the attention of our readers generally to Electric Clocks. This newest addition to horology requires putting into the form of history, and there are several points in relation to it which would be instructive if properly discussed.

WHAT IS HOROLOGY?

(*Continued from page* 61.)

THE INVENTION AND EARLY HISTORY OF CLOCKS.

The peculiar characteristics of the science of Horology seem to have enlisted among its students a large number of scientific men; in fact, it has been a favourite hobby with a great number of mechanicians in the scientific sense of the term. The greatest philosophers, as well as men of the most exalted rank, have added their contributions to the common stock; and although all that has been done in this way cannot be deemed of moment, yet we must not forget that it is by these means we have approached so near to perfection.

We have seen how clepsydræ or water clocks gradually superseded sundials, and were improved by the addition of wheel work and other mechanical appliances, so that their indications were more conveniently registered and read, and were also far more accurate than in the form in which they were first constructed.

The use of the term *horologium*, as applied *to all instruments* for the measurement of *time, leaves us in great* uncertainty as to the period to be fixed for the invention of clocks with wheels having a maintaining power and a regulator. The term "clock" itself is either from the German "*die gloke*," or from the French "*le cloche*," and throws little light upon the subject.

Different authors have quoted with confidence passages from the more ancient writers in confirmation of their opinion as to the origin of clocks. Hence Archimedes and Possidorius before the Christian era, Boethius in the fifth century, Pacificus about the middle of the ninth, Gerbert at the end of the tenth, Wallingford near the beginning of the fourteenth, and Dondi at the end of the sixteenth, have severally been asserted to have been the first contrivers of a clock.

The sphere of Archimedes, made 200 years before Christ, as mentioned by Claudian, was evidently an instrument with a maintaining power, but without a regulator, and therefore would not measure time in any other way than as a planetarium turned by a handle measures, or rather exhibits, the respective velocities of the planetary bodies.

The same may be said of the sphere of Possidorius, 80 years before Christ, as mentioned by Cicero. When Bernardus Siccus ascribes the invention of clocks to Boethius in the year 510, he passes over that part of

the quotation from Cassiodorus which says, that the hours were determined "*guttis aquarum*," that is, by drops of water; hence his *horologium* was evidently nothing more than a clepsydra. The authority upon which Pacificus, archdeacon of Verona, has been deemed the inventor of clocks in the year 850, is the occurrence in his epitaph of the words "*horologium nocturnum*," or night clock; but this designation is evidently used in contrast with or opposition to "*horologium diurnum*," or the sundial. Bailey, indeed, in his "History of Modern Astronomy," asserts that Pacificus was the inventor of a clock going by means of a suspended weight, an escapement, and a balance; but, as it has been remarked by Berthoud, he has adduced no authority whatever for the assertion. With respect to Gerbert, who became Pope Silvester II. in the year 999, the evidence is very slender, as he merely speaks of an *horologium* which he fixed by observations of the pole-star. From Leland's description of Wallingford's *horologium*, fancifully called Albion (or All-by-one), made in 1326, it must have been an instrument classing with our orreries rather than our clocks, for the motions of all the heavenly bodies appear to have been conducted by the maintaining power, whatever it was, without any controlling or regulating mechanism.

The *horologium* of Dondi, however, seems to have been a true clock. It was constructed at Padua about the end of the fourteenth century, by order of Hubert, Prince of Carrara, and is described as designating the twenty-four hours of day and night, being placed on the top of a turret or steeple, and thus corresponding exactly with our church or turret clock. Dondi was afterwards called *Horologius*; but it is not certain that he was the inventor in the true sense of the word. As with clepsydræ or water clocks, the construction of the clock properly so called was elaborated piecemeal by successive improvers; and when at last put into a presentable form, the last improver got the credit for the whole.

The earliest clock of which we have any authentic record was placed in the tower of Charles V.'s palace in 1364, and was made by Henry de Vic, or de Wick. Although this is the most ancient clock of which we have any particular description, it is said by a pretty good authority that eight years before one was erected at Bologna. In Rymer's Fœdera we have mentioned the protection of Edward III. to three Dutchmen, Orlogiers, who were invited from Delf to England in the year 1368, from which time we may probably date the introduction of clockwork into England. An account of a clock erected at Strasburg about the year 1370 is also given by Conradus Dasypodius. According to Froissart, Courtray had a clock about the same period, which was carried away by the Duke of Burgundy in the year 1382. At Spire there was a clock in the year 1395; Nuremberg had one in 1462, Auxerre in 1483, and Venice in 1497; and, on the authority of Camaldulensis, clocks began to be common in private families on the continent about the end of the 15th century. It is also probable that clocks began to be general in England about the same period, from the well-known lines in Chaucer:—

> "Full sickerer was his crowing in his loge,
> As is a clock, or any abbey orologe."

Of all these clocks, however, we only have particular details of that made by Henry de Vic, to which we have just alluded. *Figures*

Fig. 14.

Fig. 15.

14, 15, 16, and 17 represent this clock in front and in profile. We will briefly describe the parts, although a clockmaker would at once recognize them. A is the weight, and B the barrel, around which the line supporting the weight is coiled. C C and D D are the plates, which in this ancient clock were of iron; the first being bent at right angles at the ends E E, and secured to the latter by nuts instead of pillars as in modern timepieces. At F is the ratchet and click, which was precisely similar to our own. G G is the great wheel, in addition to which a second wheel, Q, was fixed to the barrel, into which geared a lantern pinion, P, on which was placed the winder. This contrivance was adopted to lessen the labour of winding, as the weight was very heavy. The great wheel turned the pinion and wheel H, which took into the pinion *g* of the escape or crown wheel, I I. K is the verge, and L L the balance, with weights, *m m*, capable of being set at different distances from the centre. A pinion, *b*, on the axis of the barrel, turned the hour wheel N, on the arbor of which was placed the hour hand. The striking part is shown at *figures* 15 and 17;

Fig. 16. *Fig.* 17.

A B being the plates or bars, F the weight, C the barrel, *b c* the pins for raising the hammer tail, and L the fly. The pinion *f*, on the axis of the barrel, turned the count wheel N, and the lever T is lifted by the pins in the hour wheel N at the required times, thus relieving the mechanism of the striking part.

It will thus be seen that the common Dutch clocks of the present time are similar in every respect, except the escapement, to this first *clock of which we have any* record. Nearly if not quite the whole of the machinery of this clock was of iron. Its size was large, probably as large as our largest turret clocks.

The imperfections of these earlier contrivances were exceedingly great, so great that minutes were too small a space of time to be measured by them. The materials were capable of oxidation by the atmosphere; and, above all, the escapement was subject to great irregularities, arising partly from the imperfection of the governing power of the balance, and also from alternations of temperature.

It soon, however, became evident that a clock would be of great value to the astronomers, and very speedily we find record of their use in observations. In 1484 Walther made use of a balance clock for observatory purposes, as did the Landgrave of Hesse after him; and soon afterwards, in 1530, Gemma Frisius proposed that a portable one should be used at sea for ascertaining the longitude. About the year 1560 Tycho Brahe was in possession of four clocks which indicated hours, minutes, and seconds; the largest of which had only three wheels, one of which was three feet in diameter, and had 1200 teeth in it. Tycho appeared to be the first to notice that there was an irregularity in the going of his clocks which depended upon the changes in the atmosphere; but he does not appear to have known how such an effect was produced. In the year 1577 Moestlin had a clock so constructed as to make just 2528 beats in an hour, 146 of which were counted during the sun's passage across a meridian line, and thus determined his diameter to be equal to 34 minutes 13 seconds, – a very close approximation to the truth.

Even thus early in the history of both sciences we find that horology became interwoven with astronomy to such an extent that the cultivation of one led to improvements in the other, while the reaction of improved instruments led to further advance in observation and increased accuracy in recorded facts.

An early addition to clocks for private use was the *alarum*, intended to ring only at certain hours to which the mechanism may have been adjusted. This took its origin from the circumstance, that in monasteries prayers were recited at certain fixed hours of the night as well as of the day. The monks were not always found unfettered by sleep at the needful moment, and therefore this contrivance was invented to arouse the drowsy *religieux* to a due sense of his duties.

(To be continued.)

ON CONTROLLING THE MOVEMENTS OF ORDINARY CLOCKS BY GALVANIC CURRENTS.

By John Hartnup, F.R.A.S.

(*Read before the British Association, Sept.* 1857.)

To the Editor of the "Horological Journal."

Mr. Editor,—Herewith I send you (with his permission) a description of the method employed by Mr. Hartnup, the very able Manager of the Liverpool Observatory, on the controlling of distant clocks by electric current transmitted from a Normal clock stationed in the Observatory. I can myself bear witness to the effectual manner in which the arrangement is carried out; for, while in Liverpool a few months ago, it was explained to me, that the Town-Hall clock and also a clock in the Exchange were both under the control of the Observatory clock. Being anxious to see the effect of this ingenious arrangement, I went to the Town-hall, and carefully watched the seconds' hand of the dial in the Exchange, and could not detect the slightest interval between the arrival of the hand at the sixtieth second and the sound of the first blow of the hammer on the bell of the Town-Hall clock as it proclaimed the hour in the turret above. I must state, very great pains are taken with the Normal clock in the Observatory; its time is brought up every day from careful astronomical observations; and you will at once see the advantage, to the merchants on 'Change and others, in having Greenwich mean time transmitted to them at every hour throughout the day, Respectfully your's,

W. B. Crisp.

Since the application of electricity to the purposes of the telegraph, various methods have been had recourse to for working clocks at distant stations by a Normal clock at an Observatory, or by causing one clock in a large establishment to work several sympathetic clocks in different parts of the building.

The advantage of being able to make several clocks show the same time as a Normal clock, regulated by astronomical observations, or by the transmission of time signals from an observatory, must be admitted to be great; but those who have had much practical experience in the matter are aware of the serious drawback which, in spite of every precaution, will occasionally arise from failure in the galvanic current, and which necessarily causes all the sympathetic clocks to stop. We think, therefore, that the members of the "British Association for the Advancement of Science" will be gratified to hear of an invention which sacrifices nothing in point of accuracy, and which is nevertheless perfectly exempt from the objection to which we have alluded.

For the discovery of this simple and very beautiful method we are indebted to Mr. R. L. Jones, of Chester, and the first application of it to a large public clock was to that of the Liverpool Town-hall. This clock, being appealed to by the merchants on 'Change as the standard of time, had subjected them to great inconvenience by its irregular performance, and, at my recommendation, the plan of Mr. Jones has been adopted with perfect success.

The clock in its present state, with the improvements which have been made, differs in no respect from an ordinary old turret clock, except that the pendulum-bob is a hollow electro-magnetic coil, which passes around permanent magnets at each oscillation. At each transmission of a current from our Normal clock at the Observatory, the coil itself becomes a magnet, and the attraction or repulsion between it and the permanent magnets prevents the pendulum from oscillating except in strict conformity with the pendulum at the Observatory.

The wire which connects the Town-hall clock with the clock at the Observatory is about one mile in length, and the controlling power is so great, that a single cell of a Smee's battery, charged with very weak acid, is sufficient to control the movements of the Town-hall clock, even when the pendulum is lengthened or shortened so as to make it lose or gain several minutes a-day when not under the control of the clock at the Observatory. In practice, however, the pendulum is regulated to correct time as near as possible, so that, in the event of the current failing, the clock will not only continue to go, but it is liable to the errors only of an ordinary clock; and as an error so small even as a fraction of a second is sufficient to show that the current is not controlling, the fault may be detected and the remedy applied before the public are subjected to any inconvenience.

By this method, therefore, it is quite practicable to make all the public clocks in a town, or any number of clocks in a large building, strike, or keep the same time to a fraction of a second, without the risk of inconvenience by failure of the electric current, since all the clocks would go as ordinary clocks, should the current fail.

This method of controlling the pendulum of a large public clock has been in operation at Liverpool for several months past, and the public have an opportunity each hour of the day of witnessing the efficiency of the method. In the office window of the Magnetic Telegraph Company, which is within a few yards of the Liverpool Town-hall, there is a

sympathetic seconds clock, the face of which is exhibited to the public. This clock is worked by our Normal clock at the Observatory, and as the seconds hand, at the end of each hour, falls upon the sixtieth second, the first blow of the hammer of the Town-hall clock breaks upon the ear, much to the admiration and astonishment of a large number of persons who congregate daily to witness this novel performance.

The Normal clock at the Observatory is an ordinary astronomical clock, the contact springs of which are so slight as not to interfere sensibly with its performance. It will be seen therefore, that, by placing a good astronomical clock in any building, a turret or any other clocks may be connected, and their movements controlled by it, and a degree of accuracy secured which has hitherto not been attained.

PLATES ILLUSTRATIVE OF THE PRINCIPLES OF MR. HARRISON'S TIME-KEEPER.

(*Continued from page 65.*)

FIG. 5.

Thickness of the rim, about 0·012 of an inch.

The discharger and wheel for the seconds must be a little nearer the dial plate than according to this drawing, so that the tops of the pins of the discharger may be even with the plane of the pillar plate.

The crosses of the wheel are also drawn too broad at the outer end.

Diameter of the hole in the centre of the wheel, about 0·0575 of an inch.

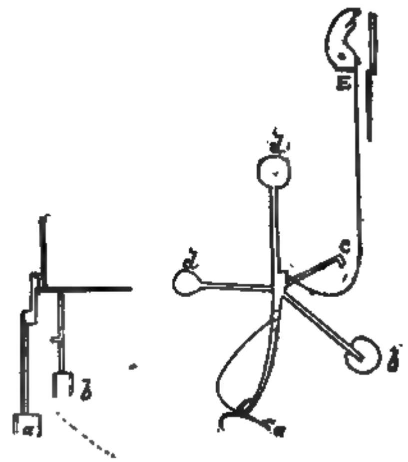
Diameter of that part of the spindle which goes through the fourth wheel arbor (thicker end), about 0·027 of an inch.

Diameter of each pivot, 0·01125 of an inch.

Length of the spring 10 inches; its weight 3½ grains.

A A represents the Contrate Wheel; B B, a Section of it, with a Section of the Spring Barrel *a a*. At *c c* is a piece with eight pins in it, that discharges the running wheels every eighth part of a minute. This wheel is also represented in Figure 14, by the circle *h h*; it has 120 teeth, *and acts in* a pinion of 12, at *i*.

FIG. 6.



This space is too wide.

The part marked *a* is somewhat too short.

Is the Dittent [detent], by which is the Discharge for winding-up Eight times in a Minute. The part *a* acts at the Eight Pins on the Contrate Wheel Arbor; *b* is a Roller acting against a piece of brass on the Fifth-Wheel Arbor; *c* is a Piece that stops against a Pin in the rim of the Fifth Wheel; *d d* are pieces of brass to make it in an equilibrium in itself; and E is the Spring which acts upon it. The centre of this Dittent [detent] is at *x* in Figure 14.

Fig. 7.

A is a Section of the Frame, with the Balance-cock, the Slide, and the Brass Edge; and *a* is the Centre of the Joint-pin.

B is a Section; where *a a* represents the Balance-cock,

b b the Third Wheel Cock.
c the Cock at the end of the Contrate Wheel.
d the Cock at the end of the Fourth Wheel.
e the Fourth Wheel.
f the Follower.
g the Balance Wheel.
h the Potence.
i the Balance-Wheel Pinion.
k the Counter-Potence, which also carries the other end of the Fourth Wheel.
m the Spring Barrel.
n the Hook in it, where the outer end of the Spring hangs.
o the Hook at the Contrate Wheel, where the inner end of the Spring is hung.
r the Fifth Wheel, with the Pin where the Dittent [detent] is to stop.
s the Upper Plate.
T the Pillar Plate.

A FEW WORDS IN DEFENCE OF

ENGLISH WATCH-WORK.

BY A MECHANIC.

[The following paper has been forwarded to us in fulfilment of a promise made some time since by one of our Correspondents.]

Lest I might be thought impertinent in choosing the above heading, I beg to explain, that I am fully aware that English watch and chronometer makers ought to require no defender. Neither do I think, if they were a united body of men, there would be any place for the following paper. But when I see the attacks that have become fashionable of late, I cannot help concluding that there must be many experiencing the feeling, who do not like to render audible what may well be styled a national sentiment—namely, a pride in the worthies of bygone days, and in the infinite variety of contrivances purely English that have developed an art, which in its infancy was but the parent of philosophical toys, into the glory and admiration of scientific mechanics.

It is to be hoped that the Institute just founded will succeed in "regimenting" the divided and isolated artists in these curious and instructive trades; so that, whereas at present they are weak by division and antagonism, they may in time discover the power of union—for whenever that time arrives, I know enough of them to foretell a phalanx quite Macedonian in its force and compactness.

Notwithstanding that England is, as it were, the birth-place of horological machinery, it has become somewhat fashionable to laud the productions of other countries, in contradistinction to instead of in conjunction with those of the parent state: I say the *parent* state advisedly, for although attempts were made in Germany as early as the thirteenth century to construct a mechanical time-metre, the productions of those days bore about the same relation to the modern chronometer as the drum does to the pianoforte.

The series of papers entitled "What is Horology," now being published in the columns of this Journal, has enabled me to omit what would but have encumbered the sort of bird's-eye view which I desire to present of the subject under consideration, and to go directly to the making of such a selection of features in the picture, that it will be easy for the reader to fill up the details to any extent he may desire; all these details being the everyday business of the artist, but matters for *arrangement* to the amateur. Thus, after the *discovery of the comparative* isochronism of pendulous bodies, the successive steps that led to the decent performanee of timepieces, and consequently the bestowal upon them of good workmanship and material, may be arranged as follows:—the fusee;—the pendulum, or secondary spring;—the horizontal escapement;—the going fusee, or maintaining power;—the duplex escapement;—the lever escapement;—the detached escapement;—the isochronism of properly arranged pendulum springs;—and the compensation balance. This list might be swollen by the enumeration of those more subtle niceties for auxiliary compensation, magnetism, &c., &c., which, being without the range of unscientific ken, would be misplaced in a paper aspiring only to the purest popularity.

Omitting therefore completely the chronology of the subject, with its corresponding disputes about authorship and priority of invention, let it suffice to recapitulate these salient points in the progress of the art, and give to each a little consideration touching the influence each in its sphere must have exerted on the ultimate development of the modern pocket watch—for it is in relation to this latter that there exists a dearth of information, and a consequent source of dispute, which it is the writer's desire to remove.

First, then, of the *fusee*. So long as fixed machines were the only timekeepers desired, the descent of a weight hung to a cord supplied the most regular and equable pull that could be wished; but, so soon as it was contemplated to make a portable one, a different prime mover became necessary. The most obvious form that suggests itself to the mind in this difficulty is a long strip of elastic material—say, tempered steel—wound round a small drum or the axle of a wheel, attached to the same at one end and to some fixed point at the other, so that if coiled up by turning the drum or axle it would give motion to the said axle by endeavouring to uncoil. This, with slight modification, is the *going barrel*, and is manifestly the most rudimentary idea of a prime mover for a portable timekeeper. Some persons may fancy the flexure of a bar still more simple; but if they will apply the rule applicable to these cases, or inspect one of Mr. Holl's patent watches, in which this form of prime mover is employed, they will at once see that such is not the case. The enormous difference of force exerted by this going barrel form of prime mover between the first and last portions of its efforts to unbend, produced corresponding irregularity in the rate of motion of the machines, and the fusee was designed to obviate this difference, and produces its effect by presenting a leverage to the pull of a chain wound round the spring box exactly corresponding with the

varying forces. It consists of a conical piece of brass mounted on an axis, which axis passes through the first wheel of the watch. The surface is cut into a groove, and the chain connects this grooved cone with the barrel, which is left a plain drum. As a going barrel, the first wheel is made on the surface of the barrel.) The small part of the cone acts when the spring is most coiled or bent, and the large part when run nearly down. Thus the compound of strong pull and short leverage is the same as weak pull and long leverage, easily represented by figures, thus :—

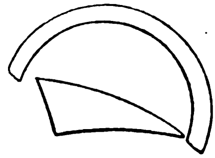
Strength of spring.	1	2	3	4	5
Diameter of cone..	9	8	7	6	5
	10	10	10	10	10

It has been usual to describe the fusee, as this conical piece of brass is called, by reference to geometrical forms and very nice calculations ; but I prefer to follow this simple path; for although the proportion of parts is to be very accurately calculated, I doubt much if ever a well-adjusted fusee was yet produced by calculation, while on the other hand trial in error, repeating experimental alterations, as indicated by the irregularities of each spring, may in all cases lead to adjustment so perfect that nothing is left to be desired. On the other hand, notwithstanding that the going barrel has received great attention, and has been improved immensely in modern timepieces by employing a large number of turns and using only a portion of them, at the same time making the spring tapering, the thick end being the first bent up and the thinner the last ; still, with all that has been done for it, the going barrel remains the most irregular of prime movers.

There can be no doubt that the effect of even the roughest approximation to a good-shaped fusee must have effected a great improvement in the regularity of the piece to which it was applied ; but I fancy that, had the next grand step happened to have suggested itself a little earlier to his mind—it sprung from the same brain—we might have waited some considerable time longer for the fusee, capital contrivance as it is. This grand step was the *pendulum spring*, known only for a long time after its production as the *hair spring*, from its slender proportions. Its employment for returning the balance to its original or mean position after each excursion, as gravitation does the pendulum, converted the balance at once into a time-measurer ; it deposed the train of wheels and spring from the governing point, making them secondary always to itself ; and the continued study and improvement of this spring have been the principal means of developing the chronometer. Curiously enough, it has even been found that it can be employed to render more perfect the pendulum itself, by aiding it to get over the effect of departure from that curve which is the only equal-timed one, and which the ordinary pendulum does by a considerable increase in the extent of its vibration. (*Loseby's bridle.*)

The next step was the invention of the *horizontal* or *cylinder escapement.* This is a very ingenious reduction of the dead-beat clock escapement to the portable form as follows. The small action or *locus* of motion in the pallets of a clock was converted into one of large angle, as required in a watch, in the following manner :—The driving part of the escapement-wheel tooth is made somewhat of the shape of a ploughshare, and raised above the general level of the wheel by being mounted on a pin, thereby obtaining the power of allowing the pallets (the cylinder) to circulate round it nearly a whole turn, thus :—

Fig. 1.



This wheel was made and cut by engine all in one piece, and was so difficult of execution that, notwithstanding the escapement was discovered to possess properties so desirable that it revolutionized the trade, there was always a desire to produce something possessing as good qualities but less difficult to execute. But it still maintains its ground, partly from its own intrinsic good qualities, and partly from its adoption by the Swiss, who made it the basis whereon to build up a cheap manufacture, and thus it has become the foundation of the large watch trade of that country.

The history of its adoption by the Swiss is so curious that it cannot be misplaced here, showing as it does the folly of allowing old rules to blind inquirers to the recognition of novelty, seeing that there may belong to novelty some hidden advantage that might never have been suspected but for experiment. The horizontal escapement was invented in England, and was found by its frictional action during the state of rest of the train so nearly to counterbalance the variable impulse given by the spring, that even with crude going barrels the average performance of the watch was amazingly improved. English engineers had, by experiment, proved that friction was much less between different metals than between similar, therefore the watchmaker made the horizontal wheel of brass and

his cylinder of steel. Meanwhile public taste demanded flat watches, and the Swiss made the horizontal escapement of steel entirely, thereby sacrificing theory to demand. After a time it was found that, whereas the brass wheel destroyed the cylinder very quickly, the steel wheel hardly marked it in years of wear, clearly shewing that even if there be a slight excess of that friction that retards motion, it is a less evil than the absolute wear of the machine itself. The Swiss were thus rewarded for studying the taste of the public by a large trade, and have made their country the home of the horizontal escapement.

(To be continued.)

DECIMALS. No. 3.

(Continued from page 54.)

It will have been perceived by those who have carefully perused our former articles on this subject, that in all cases, in the addition or subtraction of decimals, it is indispensable that the decimal point in each row should stand directly under that in the one above it. This, however, is not necessary in multiplication, of which we are now about to treat.

In the multiplication of numbers involving decimals the operations are performed exactly as in common arithmetic, nothing more being necessary in arranging the numbers than to take care to place the *multiplicand* (or number to be multiplied) and the *multiplier* (or number by which we multiply) in such a position that the right-hand figure of the latter stands directly under the right-hand figure of the former; except in those cases where the multiplier terminates with one or more ciphers, in which case it must be placed as in Example 1, below. Examples 2 and 3 are also given to shew the mode of arranging the numbers.

(Ex. 1.)	(Ex. 2.)	(Ex. 3.)
·6784	242·06	31417 multiplicand
500	1·723	·0002 multiplier

Whenever the ciphers which terminate the multiplier are decimals, they may be discarded altogether; for as our young readers will ere this have discovered, the addition of any number of ciphers to the right-hand of a decimal does not in any way affect the value; thus, ·100, ·2000, ·300000, are respectively of the same value as ·1, ·2, and ·3.

We have said that the student must proceed in the multiplication of decimals exactly the same as in that of whole numbers; but, *to insure a correct result,* he must mark or *point off for decimals in the* product as many figures from the right-hand as there are decimal figures in the multiplicand and multiplier together, as will be seen in Example 9. But should there not be so many figures in the product as there are in the two factors * taken together, as in Example 10, then must as many ciphers be prefixed to the product before the decimal point is affixed as will make the number of decimal figures in the product equal to the number in both the factors. The reason for this we shall explain presently.

Before proceeding further with our subject, we deem it necessary to make a few remarks on the term *multiplication*, in order that our young readers may the more thoroughly understand the subject. The idea of *multiplication* is almost universally associated with that of increase, and, when applied to whole numbers, correctly so. The student, however, in the case of decimals—and, indeed, of fractions generally—must divest himself of that idea, and learn to contemplate the subject in a different view. If the whole numbers 6 and 4 are to be multiplied together, 6 is to be taken 4 times, or 4 is to be taken 6 times, and the product in either case will be 24, which is greater than either of the factors 6 or 4; and whenever whole numbers are multiplied together the product will always be greater than either of the factors employed, except in the case where one or both the factors are unity, in which case the product will be either unity or the same as the greater factor. Our young friends will readily understand that any number may be taken one, two, three, or more times, and that the product will be once, twice, thrice, or more times the amount of the original number. Now let the student go below unity, and conceive the possibility of taking the number less than once—say a half, a third, or a tenth of once, and let him reflect upon what the products must be in those cases. We think it will be clear to his mind that they must be in each case less than the original number. If he comprehends this, he will have a clear notion of the fact, which is so often a stumbling block to young students in decimal arithmetic—namely, that one number should be multiplied by another, consisting even of several figures, and that the product of the multiplication should be less than the original number, or possibly less than either of the numbers employed in the process, or, in other words, than either of the factors. We will endeavour to make this plain by asking

* By the factors of any number are meant such numbers as when multiplied together will give that number as a product: thus, 2 × 3 × 4 make 24, therefore 2, 3, and 4 are factors of 24; so also are 8 and 3, 4 and 6, as well as 2 and 12.

(Ex. 4.)
$$\begin{array}{r} 5 \\ \cdot 1 \\ \hline \cdot 5 \end{array}$$

(Ex. 5.)
$$\begin{array}{r} 5 \\ \cdot 2 \\ \hline 1 \cdot 0 \end{array}$$

(Ex. 6.)
$$\begin{array}{r} 5 \\ \cdot 4 \\ \hline 2 \cdot 0 \end{array}$$

and answering a question. If we have to multiply any whole number by a decimal, such as 5 by ·1, or by ·2, or by ·4, how many times have we to take 5 in each of these cases? The answer will be, not once, twice, or four times 5, but one-tenth, two-tenths, or four-tenths of (once) 5; for, although in performing the examples we say once 5 is five, twice 5 are 10, and four times 5 are 20, still we in fact only mean one-tenth of 5, two-tenths of 5, and four-tenths of 5, and the products in the three cases will be five-tenths (one-half), one, and two.

(Ex. 7.)
$$\begin{array}{r} \cdot 5 \\ \cdot 1 \\ \hline \cdot 05 \end{array}$$

(Ex. 8.)
$$\begin{array}{r} \cdot 4 \\ \cdot 2 \\ \hline .08 \end{array}$$

We will now multiply one decimal by another. (See Examples 7 and 8.) In these two examples the mere multiplication would only give for the product, in the one case 5, and in the other 8; but both the factors in each example are decimals, and therefore require two decimals in the product, and consequently a cipher must be prefixed before the decimal point can be placed in its proper position.

It will be seen by the foregoing examples that in multiplying any number whatever by any decimal (no matter of how many figures the decimal may consist), the product can never be equal to the original number, and for this reason, that, in thus multiplying, we only take such a part of the number as the decimal is a part of unity.

(Ex. 9.)
$$\begin{array}{r} 5 \cdot 246 \\ 3 \cdot 802 \\ \hline 10492 \\ 41968 \\ 15738 \\ \hline 19 \cdot 945292 \end{array}$$

(Ex. 10.)
$$\begin{array}{r} \cdot 4622 \\ \cdot 02003 \\ \hline 13866 \\ 9244 \\ \hline \cdot 009257866 \end{array}$$

Examples 9 and 10, which are rather more extended, are here given to show the mode of pointing off.

In example 9, one of the factors is 5·246, that is five, and two hundred and forty six thousandths; and the other is 3·802 (three, and eight hundred and two thousandths); and the product is 19·945292, or nineteen, and nine hundred and forty-five thousand, two hundred and ninety-two millionths of another unit, being very nearly, but not quite, equal to 20. In example 9 each factor contains three decimals, therefore in the product six places to the right are pointed off for decimals, in accordance with previous instructions.

In example 10, the multiplicand consists of four, and the multiplier of five places of decimals, and consequently there *must* in the product be nine figures from the right for decimals. Now the multiplication of these numbers together, omitting the ciphers, would give only 7 figures in the product, which not being so many by two as there are decimal figures in the two factors, it is necessary to prefix two ciphers in the product, which makes ·009257866 as in the example.

It may and most likely will be asked by our observant young readers, Why point off as many places in the product as are contained in both factors? We will answer by asking another question. Have you not observed, in the examples given, a certain result which takes place in every multiplication by a decimal? We think you must; but, lest you have not, we will point it out. It is this,—that whenever any whole number is multiplied by a decimal, the unit figure of the whole number is thereby converted into a decimal; and every decimal multiplied by a decimal is converted into a decimal of the next lower denomination; and hence it becomes necessary to remove the decimal point for each such multiplication one point further to the left hand, thus increasing the number of decimal figures in the product over and above the number in the multiplicand by just so many figures as there are decimals in the multiplier.

We shall here conclude the subject of *multiplication*, without entering into the contracted methods of performing examples containing a great number of figures, because we are satisfied that the pupil who will carefully attend to what has been advanced in this and the two previous articles will find no difficulty in adopting the contracted methods when it becomes advisable for him to do so.

It was our intention to insert in the present number the observations on *division*, but are compelled to omit them for want of space.

Curious Clocks.—M. Schwilgue, clockmaker of Strasburg, son of the maker who restored the curious astronomical clock of the cathedral of that city, is now exhibiting two clocks made under his directions for the Bey of Tunis, which have each two faces—one showing in Roman figures the 12 hours used in Europe, the other the 30 divisions of Turkish time. The rise and decline of the moon are also shown by a disc, which rises from one cloud and slowy disappears in another. Each of the clocks has cost 5000f.

[We are glad to state, that a copy of the Life of the elder Schwilgue, by his son, has been presented to the library of the Institute by Mr Roberts of Manchester.]

PROPOSED EXHIBITION IN 1861.

To the Editor.

SIR,—I had the honour of addressing you some months since on the subject of the proposed Exhibition in the year 1861, in furtherance of which the Society of Arts has again moved. As that communication was favourably received, I beg to renew my suggestion, especially as the like notion appears to be entertained by the Council of that body; in proof of which I beg herewith to hand you a circular letter, &c. from them to the members, and which I think deserves consideration.

I may add, that it is my intention to lay the subject before the Council of the BRITISH HOROLOGICAL INSTITUTE, in the hope that they, too, may take action in the matter, so that Horology may have fair play.

GNOMON.

" EXHIBITION IN 1861.

" At a Special Meeting of the Council of the Society for the Encouragement of Arts, Manufactures, and Commerce, the following resolutions were passed :—

" The Council of the Society of Arts, bearing in mind the part which the Society took in originating the Great Exhibition of 1851, have considered it to be their duty carefully to examine various suggestions for holding an Exhibition in 1861, which have been submitted to them, and have resolved—

" 1. That the institution of Decennial Exhibitions in London for the purpose of showing the progress made in Industry and Art during each period of ten years, would tend greatly to the Encouragement of Arts, Manufactures, and Commerce.

" 2. That the first of these Exhibitions ought not to be a repetition of the Exhibition of 1851, which must be considered an exceptional event, but should be an Exhibition of works selected for excellence, illustrating especially the progress of Industry and Art, and arranged according to classes, and not countries; and that it should comprehend Music and also Painting, which was excluded in 1851.

" 3. That Foreigners should be invited to exhibit on the same conditions as British Exhibitors.

" 4. That the Council will proceed to consider how the foregoing resolutions can be best carried into effect.

" P. LE NEVE FOSTER, *Secretary.*

" Society's House, Adelphi, London."

" SOCIETY OF ARTS, MANUFACTURES, AND COMMERCE, Adelphi, London, W.C.

" 30*th December*, 1858.

" SIR,—The Council of the SOCIETY OF ARTS, in considering the best means of setting on foot another *Exhibition* in the year 1861, must request the co-*operation of the whole of the* Gentlemen who, from *the very fact of their being* members of the Society of Arts, may be considered to have the " Encouragement of Arts, Manufactures, and Commerce" at heart.

" 1. I am therefore to request, that you will be good enough to favour the Council with any observations which your experience may suggest upon the best mode which may be adopted of representing the Industry of the Metropolis, and particularly of any branch of it in which you may happen to be directly or indirectly interested.

" 2. They would request you to state, at your earliest convenience, whether any and what improvement you consider could be made on the arrangements of 1851.

" 3. Whether the conditions sketched out in the resolutions of the Council published in the 282nd number of the Journal (see copy enclosed), and again in the opening address of the Chairman of the Council, require any modification or extension.

" 4. Whether you consider that the formation of Metropolitan Committees would be of use in discussing the preliminary details, and whether there is any particular class of industry upon the Committee of which you would prefer to serve. You must be good enough to understand, that the functions of such Committees must in the first instance be purely deliberative, as the Council are unable to decide how and by what agency the Exhibition will be conducted, until they receive a reply to their application from the Commissioners of the Exhibition of 1851. You may, however, be assured, that whatever thought and attention you may be good enough to devote to the subject, will be of great advantage to the undertaking. " I am, Sir, your obedient Servant,

" P. LE NEVE FOSTER, *Secretary.*"

THE NEW METAL ALUMINIUM.

To the Editor of the HOROLOGICAL JOURNAL.

SIR,—You favoured us a short time since with a suggestion of " Cornhill's " on the employment of the new metal aluminium for watch dials. Although I have not entered far into any enquiry as to the chemical properties of this metal, especially in the frosted state, I think it would at least be prudent to try the effect of sulphuretted hydrogen upon it, as well as the effect of an atmosphere impregnated with the perspiration of the human body, such as a watch must necessarily be subjected to. I make these suggestions because I have found the material fail in its first promise of usefulness in a manner least expected—namely, in a curious alteration under the rolls or the hammer, whereby it becomes softer, and that to an extent that deprives it of all applicability to delicate wheelwork or other such machinery.

Thus I apprehend the plate for a dial would require, for stiffness' sake, to be left five or six times at least as thick as a silver one can be made. Your's, respectfully,

VERTICAL.

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

Printed by order of the Commissioners of Patents, and published at the Great Seal Patent Office, 25, Southampton-buildings.

(*Continued from page* 71.)

1762, April 20.—No. 771.

MARIE, David.—The watch is wound up with a single turn, in consequence of the barrel having but one turn; goes thirty hours, and also during the time of winding up by reason of the last turn of the spring only being made use of. There is no chain or fuzee. As to wheel and pinions, the first is the pinion to the barrel which winds up the spring, and has six teeth, and plays into a steel wheel of eight teeth, which last wheel has a large plain tooth, and prevents the watch being over-wound. A click plays into a "rochett," and prevents the watch being wound the wrong way. A bar fixed to the barrel keeps the spring in its proper strength. The large brass wheel fixed to the centre, the second wheel, the third or centre wheel, the fourth wheel, the fifth wheel, and the balance wheel are placed according to a callipper to the specification annexed. The rest like as in other watches.

[Printed, 5*d*. See Rolls Chapel Reports, 6th Report, p. 132.]

1762, April 20.—No. 777.

SANDERSON, George.—A lunar and calendar watch key. There are two wheels one of which has one hundred and seventy-seven teeth cut on its edge, with the days of the moon's age expressed on it; the other wheel has one hundred and eighty-six teeth cut on its edge, with the days of the month expressed upon it. These wheels are in a case or cover having apertures on either side to show the various figures, and they are moved forward at the time of winding up the watch by means of a worm or endless screw in that part where common watch keys are generally rivetted. The winding up of the watch (generally done in six revolutions) moves the figure on each side one day forward. In months having less than thirty-one days the day or days remaining must be passed over by giving the key six revolutions for each day. The lunar plate will thus have to be turned back to its proper figure, which is done by a knob for that purpose. There is also a nut or screw to tighten the key when slack, and a catch to prevent accidental turnings. By another circle of figures inside that of the moon's age, divided into twenty-four parts, and having the twelve hours of the day repeated or doubled, the time of high water at London Bridge may be shown, and by making this inside circle to slide or move upon the moon wheel, the time of high water at any other place may be shown. Another circle inside this, having a curved line drawn on it, shows at another aperture the increase and decrease of the moon. By another wheel may be shown the day of the week. This wheel has eighty-four teeth, and has a moveable circle on it with the days of the week repeated or doubled. The key may be used without a watch by merely turning the key six revolutions,

[Printed, 5*d*. See Rolls Chapel Reports, 6th Report, p. 158.]

1764, November 29.—No. 819.

KEHLHOFF, Friederieck.—An ordinary spring so works on a snail that when the mainspring is in the greatest power this spring pushes fast upon the snail, and diminishes the force of the main-spring, and as the main-spring begins to be weaker the said spring pushes less, and so the force is at all times equal. The fourth wheel is in the centre, and carries the second hand. On a pinion on its arbor is fixed one end of a little spring of the strength of a pendulum spring; the other end is fixed on the arbor of the fourth wheel. "This little spring makes the "watch go, because the power of the main-spring "goes no further than to wind up that little spring, "and is the great spring. If the second or third "wheels take in a little too deep or not deep enough, "it cannot cause an unequal pit, because" this little spring is always wound up. All the wheels are horizontal. The balance wheel has two circles, in which are pins which form the teeth. The balance has a straight arbor. The working part is of a triangular figure, and goes in the middle of the two circles of this balance. The pallets work under the pivot of the balance.

[Printed, 5*d*. See Rolls Chapel Reports, 6th Report, p. 133.]

1766, January 7.—No. 836.

HAYWOOD, Peter.—A lunar or calendar ring, consisting on the outside of four circles, one of which is fixed, and is divided into thirty parts, each part containing one of the letters of the days of the week in each month. Two moveable circles slide round this, one on either side, divided similarly, and having the numbers one to thirty round them; signifying in one the days of the months, in the other the moon's age. The fourth ring slides round a groove in the side of the last ring, and is divided into twenty-four parts, having the numbers I to XII and I to XII again round it. This is to show the time of high water. This is set on change of place, the other moveable ones once in four weeks.

A ring may be made in the form of a cluster ring, one circle being fixed and another sliding round the inside of it. The figures and letters are seen through a transparent stone, fixed in the setting.

A third ring has the fixed letters at the side of the transparent stone, and the moveable circle inside the hoop of the ring.

[Printed, 6*d*.]

Notes and Notices.

We wish it to be clearly understood by our readers, that we do not hold ourselves responsible for the views advocated by our Correspondents, but, at the same time that we offer a fair field for discussion, we exercise the privilege of our office in judging whether the subjects are of a nature suited to the objects of our Journal.

According to promise, it is the intention of the Council of the British Horological Institute shortly to commence their labours (by a Committee) on the subject of Uniform Gauges. They therefore solicit communications from members and others who may have anything to suggest on the subject.

We are prompted, by our active interest in all that concerns the Horological Trades, to notice a report, in our respected contemporary, *The Clerkenwell News*, of a Meeting of Case-makers, to receive a deputation of members of the same trade from Coventry. We refrain from any remarks upon the said meeting, but must regret that it partook exclusively of the Trades Union character, and therefore the more remarkable is the coincidence of an advertisement in the same paper of a new *Machine for Case-making*.

TO CORRESPONDENTS.

Y.—Harrison's Timekeeper is preserved at Greenwich Observatory.—We propose describing a series of gauges for the purpose of measuring angles.

Tyro.—An article is in course of preparation describing the principles and use of the Transit instrument, which will shortly be inserted in the Journal.

E. B.—Your communication was received too late for this month's number.

A Country Subscriber will find the information he requires in "Reid *on Watch Work*;"—the subject will, however, be shortly treated of in the Journal.

Declinations of the following Stars, and Times at which they are on the Meridian at Greenwich, for February, 1859.

Name of Stars.	Day of Mon.	Dec. North	Time of passing the Meridian.
		° ′ ″	h. m. s.
α Tauri (*Aldebaran.*)	10	16 13 28·9	7 6 33·14 P.M
	20	16 13 28·6	6 27 13·89 „
α Aurigæ (*Capella.*)	10	45 51 15·6	7 44 54·22 P.M
	20	45 51 16·1	7 5 34·92 „
		Dec. South	
β Orionis (*Rigel.*)	10	8 22 4·1	7 46 22·44 P.M
	20	8 22 4·8	7 7 3·20 „
α Canis *Majoris* (*Sirius.*)	10	16 31 36·4	9 17 18·28 P.M
	20	16 31 37·8	8 37 59·06 „

EQUATION OF TIME TABLE

For February, 1859.

Day of the Week.	Day of Mnth.	At Apparent Noon Equation of Time to be *added* to Apparent Time.	Difference for One Hour.	At Mean Noon. Equation of Time to be *subtracted* from Mean Time.
		m. s.	s.	m. s.
Tues..	1	13 51·00	0·323	13 50·93
Wed ..	2	13 58·75	0·289	13 58·68
Thurs.	3	14 5·68	0·254	14 5·62
Fri. ..	4	14 11·78	0·220	14 11·73
Sat. ..	5	14 17·06	0·186	14 17·02
Sun. ..	6	14 21·52	0·151	14 21·49
Mon...	7	14 25·16	0·117	14 25·13
Tues..	8	14 27·97	0·083	14 27·95
Wed ..	9	14 29·96	0·050	14 29·95
Thurs.	10	14 31·15	0·017	14 31·15
Fri. ..	11	14 31·55	0·016	14 31·55
Sat. ..	12	14 31·16	0·049	14 31·16
Sun. ..	13	14 29·98	0·081	14 30·00
Mon...	14	14 28·04	0·112	14 28·06
Tues..	15	14 25·35	0·143	14 25·38
Wed...	16	14 21·91	0·173	14 21·95
Thurs.	17	14 17·76	0·203	14 17·81
Fri. ..	18	14 12·90	0·231	14 12·95
Sat. ..	19	14 7·36	0·259	14 7·42
Sun. ..	20	14 1·14	0·286	14 1·21
Mon...	21	13 54·28	0·313	13 54·35
Tues..	22	13 46·77	0·339	13 46·85
Wed ..	23	13 38·66	0·364	13 38·74
Thurs.	24	13 29·93	0·388	13 30·02
Fri. ..	25	13 20·64	0·411	13 20·73
Sat. ..	26	13 10·78	0·434	13 10·87
Sun. ..	27	13 0·35	0·456	13 0·45
Mon...	28	12 49·40	0·478	12 49·50

*** *All Communications for this Journal should be addressed to* "*The* Editor," *at the Office*, 35, Northampton Square, Clerkenwell.

TO ADVERTISERS.

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A STANDARD OF MEAN TIME.

One of the most important elements of success in accurate timing and adjusting for temperature is the possession of a standard of comparison which shall be absolutely perfect. There can be little doubt but that if we really knew the true state of the case, we should find that many of the difficulties which are met with in timing, and the tediousness which often attaches to this essential operation, are due in great degree to the errors of our regulators, or of the standard by which we correct them. We grant, indeed, that a properly and simply constructed clock may be made to keep a very steady rate; but every one who is in the habit of watching a mechanical time keeper knows, that it may occasionally start from that rate in a manner and to an extent which may prove of serious inconvenience, at the same time that we may probably know of no cause why the variation should take place.

In order to detect these errors and prevent their consequences, it is necessary to compare the regulators either among themselves, or with the great ultimate standard,—astronomical time.

Now it unfortunately happens, that chronometer makers are dependent to a very great extent upon others for this element of success. There are few who have the inclination or the means, or (it may be) the time, to acquire the necessary knowledge and practice to enable them to observe the time by transit for themselves. An attempt has been made in one or two instances to supply this need, but not in immediate connection with our profession.

Time-balls have been erected at Greenwich, at Charing-cross, and by a private individual in Cornhill; but the situation of all these is such as to make them of little practical use, without the expenditure of a considerable amount of time on the part of the observer. The expense of these erections is a great drawback to their wide extension. But still we think, that as correct time is the one great question on which hangs the most important point in horological manufacture, we might and ought to have, in the districts where the profession is most followed, one or more of these indicators placed in a conspicuous and easily accessible position. There are many such sites in the neighbourhood where we write, upon which the erection of a time-ball which should fall by electric signal from Greenwich at some fixed hour would be a great boon to the trade. We do not confine ourselves, however, to a certain locality. Our Coventry friends ought likewise to gain their inspiration from the same fountain, and *public clocks* generally should be reduced to a more uniform standard. Can anything be more fallacious, for instance, than the indications of our ordinary church clocks—some of them striking, perhaps, several minutes wide of the hour, and scarcely any two of them shewing the same time? And what guarantee have we, that the great clock at Westminster will, even when finished—whenever that may happen—present indications that may be trusted to a second of time?

In our last number we described the system in operation at Liverpool, by which an uniform rate of going is attained in certain clocks. In this respect Liverpool has got the start of the metropolis; for here there are no public clocks under the control of Greenwich, except those of the Post-Offices in St. Martin's-le-Grand and Lombard-street, and certain railway clocks.

But the point that we desire to insist upon is, that means should be devised to supply the necessary element where it is most wanted. Is there any reason why the centres whence time keepers are distributed over the whole world should not likewise possess the means of unerring comparison? We think not; and if our readers think with us, we may yet discover a way of effecting a change.

THE INAUGURAL DINNER

of The British Horological Institute took place on Tuesday the 22d February, 1859, at the Belvidere Tavern, according to advertisement, and passed off with great success. So large an assemblage of Watchmakers has not, we believe, been gathered before for festive purposes in Clerkenwell. The greatest enthusiasm for the Institute prevailed, and nearly £100 was subscribed towards its funds. A detailed Report of the proceedings is in course of preparation, and will appear in our next Number.

WHAT IS HOROLOGY?

(Continued from page 76.)

Early History of Clocks—*continued.*

Introduction of the Mainspring and Pendulum.

The clocks we have already described, including that made by De Wick, were exceeding large and cumbersome—as large, in fact, as some of our turret clocks. De Wick's timepiece was actuated by a weight of 500 lb., and the whole mechanism, as might have been expected at that early date, was exceedingly coarse and rough.

It is not quite certain at what time the bulky size of the ancient clock was reduced, but the introduction of a spring instead of a weight must have been a most important advance in respect of portability, although introducing a new source of error. As has already been explained in this Journal, it is essential to the nature of a spring that it should exert the most force when it is most bent, and the contrary. What the result of this must have been, with rough workmanship and an escapement without a governor, as in De Wick's clock, can be "more easily imagined than described." Some years ago there was preserved in the hands of a private individual at Brussels, a clock which was set in motion by a straight spring. This spring was nothing else but a sword blade, the point of which was attached by a cord to a barrel around which it was wound. This was probably the most elementary form of the spring clock.

Berthoud, in his "*Histoire de la Mesure du Temps*," supposes that a portable clock must have been invented some time before the year 1544, which was that in which the Corporation of Master Clockmakers at Paris had a statute enacted in their favour by Francis I. to this purpose: "No one, of whatever station, if he be not admitted a master, shall make, or cause to be made, clocks, alarums, watches large or small, or any other machine for measuring time, within the said city and precinct of Paris, on pain of forfeiture of the said works and of arbitrary penalty, &c." This, however, only proves that portable clocks had begun to be commonly made in France, but shows nothing as to their origin.

There is a description extant of a portable clock, which was at one time in the possession of the eminent Ferguson, which was made in 1525 by Jacob Lech, of Prague. This timepiece had a spiral spring, with a *fusee* of soft metal, and a screw instead of notches at the ends of the arms of the balance, *with tapped weights of* lead for the adjust*ment to time. There was* also some additional wheelwork to show the motion of the sun and moon on an engraved ecliptic, and also a contrivance to strike one at every hour. The wheels were of iron, and showed punch marks of division, proving that they had been cut with a file by hand. A catgut had first been used to connect the barrel with the fusee, but a modern metallic chain has been applied, which destroyed several of the threads. Before this was done it went for 48 hours with one winding, and gave about 3600 beats in the hour.

This is the earliest instance that is found of a fusee. It was not till a hundred years after that Hooke investigated the properties of the spring, and applied the fusee to its correction; but it is impossible, at this distance of time, to say whether he improved a contrivance already known to himself or originated it entirely.

Prior to this period the equalization of the pull of the spring had been attempted by applying a second spring, which opposed the main spring when wound up, and acted in the same direction with it when its force became weakened. This was a German invention and was called *stack-fried.*

We now approach the time when a discovery in physical science was to afford the basis of an improvement which should elevate the clock at once to the position of an instrument of precision, and the study of the principles of its construction to the rank of a science.

The discovery of the properties of pendulous bodies is due to the great astronomer Galileo, about the end of the sixteenth century. That eminent philosopher having observed the hanging chandeliers of lofty ceilings to continue vibrating after any accidental disturbance for a length of time and with remarkable uniformity, was led to investigate the causes of the phenomenon, and out of what had been uselessly before men's eyes in some shape or other from the beginning of the world his powerful genius extracted the most important results.

Independently of the light which the theory of the pendulum has thrown on various branches of physics, the instrument itself is almost perfect as a time-keeper. It is desirable, therefore, here to state briefly those scientific laws which govern the motion of the pendulum, the basis of which was also discovered by Galileo, who also elaborated many of the details.

If a body is placed on a horizontal axis which does not pass through its centre of gravity, it will remain at rest only when the centre of gravity is immediately below the axis. If it be moved from this position, the body will oscillate from side to side until by

means of the atmospherical resistance and the friction of the axis it comes again to rest. A body so suspended and oscillating thus is, in fact, a pendulum.

A distinction is made between the simple or mathematical pendulum and the compound or physical one. The first exists only in theory, and is considered as a ponderous body suspended by an inflexible line without weight. It is evident that such an arrangement cannot actually exist, because a line must possess weight; but this, in common with many other assumptions, is made in order the more simply to investigate the laws and calculate the formulæ relating to the motions of pendulums generally.

All actually existing pendulums, then, are compound pendulums; the name, in fact, being applicable to any body so suspended that it may swing freely backwards and forwards.

If a pendulous body, then, be moved from its position of rest into any other whatever, and is then left free to fall, it moves backward and forward, going to an equal distance on each side of the perpendicular, ascending on the one side to a height equal to that from which it had fallen on the other. Its descent is owing to the attraction of the earth, while its ascent results from its inertia and the final velocity acquired by its fall. A pendulum will, therefore, have an accelerated motion in its descent, and a retarded motion in its ascent. Gravitation being thus the cause of the motion of a pendulum, its operation is never suspended, and a pendulum would vibrate for ever, were not its oscillation finally overcome by those impediments which it has in common with all terrestrial motions.

The vibrations of pendulums are governed by their length; that is to say, if a pendulum be lengthened it will vibrate more slowly, and the contrary. When two or more pendulums are made of precisely the same length, their vibrations are respectively performed in equal times. The reason why long pendulums vibrate more slowly than short ones may be familiarly stated to be, that in corresponding arcs or paths the shorter pendulum has a steeper line of descent than the longer pendulum. Now it is a law, that a body falls four times as far in two seconds as in one; hence a pendulum must be four times as long to beat once in two seconds as to beat one in a second, and one of one-fourth the length will beat half seconds. Thus we obtain the rule, "The lengths of the pendulums must be as the squares of their times."

A second's pendulum is one whose vibration occupies one second, and the length of such a pendulum for the latitude of London is 39·12 inches, at the temperature of 62 degrees Fahrenheit.

The effective length of a pendulum does not include the whole length of the system, but is measured from the point of suspension to what is called the point or centre of oscillation, the position of which varies as the matter composing the pendulum is distributed. Thus, if we take a pendulum having two balls or bobs, one above the other, on the same rod, the tendency of the upper ball being nearer the point of suspension will be to oscillate more quickly than the lower one, this tendency will be communicated by means of the rigidity of the wire to the lower ball and quickens its descent. Again, the lower ball has a tendency to vibrate more slowly than the upper ball, consequently the latter being attached to the former is retarded in its descent. The result of all this is, that the effective length of the pendulum, or that on which the time of vibration depends, will not be measured from the point of suspension to the position of either the upper or lower ball, but to a mean position between each. We thus see that this centre of oscillation depends very much upon the centre of gravity, which varies according as the weight is concentrated in the ball or distributed through a larger surface—as, for instance, along the rod. As an illustration we may refer to Harrison's gridiron pendulum, which we shall describe more fully in the proper place. The weight in this case being diffused over a larger space renders it necessary to construct the whole system of a greater length, to obtain vibrations of equal times.

Again, if we add weight to the bob of a pendulum, we make it vibrate slower, though we do not add to its length, because we bring down the centre of gravity, and with it the centre of oscillation, and thus increase the effective length. But if we add the weight above the centre of gravity, we shall produce the opposite effect. Hence the addition of mercury to a mercurial pendulum, it being added above the centre of gravity, raises that centre, shortens the acting length, and consequently the vibrations are quickened.

The centre of oscillation is usually a little below the centre of gravity, and is identical with the centre of percussion. If we take a stick or rod, we find that there is a certain point beneath which if we place the finger the whole system is supported in equilibrium. This is the centre of gravity. If we strike any substance with one end of a stick, holding the other end in the hand, we shall feel a jar. But if we cause the blow to be struck at about one-third of the length of the stick from the end, the whole force will be exerted upon the obstacle, and we shall feel no jar. The same effect will take place if we grasp the stick at one-third of its length and strike

with the further end. This point is the centre of percussion or oscillation, depending for its position on the manner in which the matter is distributed throughout the system.

The centre of oscillation and the point of suspension are likewise convertible points; that is, if the centre of oscillation be made the point of suspension, the former point of suspension will become the centre of oscillation, and the system will vibrate in the same time as before.

If the point of suspension be identical with the centre of gravity, the time of vibration will be infinite, that is to say, there will be no tendency to vibrate at all; but if a force be impressed, the system will tend to revolve. Thus, by prolonging the upper part of the pendulum and placing a weight at the upper end, by approaching this weight towards the point of suspension the vibrations will become quicker, till it passes that centre, when they will become slower. The effect of this upper weight is to remove the centre of oscillation to a greater distance. We may thus obtain a short pendulum which will vibrate as slowly as we please. This fact is applied in the construction of the *metronome*, a musical timekeeper, which consists of a pendulum of this description kept in motion by clock-work. The upper ball is moveable, and thereby the pendulum is made to move quicker or slower.

As gravity is the force which determines the vibration of a pendulum, any change in that force will alter those vibrations. And thus at the equator, where the gravity of bodies is lessened in a small degree by the centrifugal force arising from the earth's rotation, and also varies from the increased distance from the common centre of gravity, a pendulum vibrates more slowly than elsewhere, and must be made shorter to answer the same purpose. Corresponding results take place when a pendulum is carried to a mountain top further away from the centre of the earth, or when carried to the bottom of a mine, where it is attracted by the matter above it as well as by the matter beneath.

The actual application of the pendulum to clocks is disputed on behalf of three mechanicians—Vincent Galilei (son of the great Galileo), Huyghens, and our countryman Hooke. The first of these is said to have made a pendulum clock in the year 1649 at Venice; but Huyghens contested the honour of the priority of the application with him, and wrote a treatise "De Horologio Oscillatorio," from which it appears that he made or directed the making of a clock with a pendulum before the year 1656. But long before 1673, the year in which this treatise was published, Dr. Hooke had studied the subject, and arrived at the conclusion, that pendulums with short arcs of vibration constituted the most accurate timekeepers. He therefore, in 1656, as appears by certain records at Oxford, made a clock which moved with astonishing uniformity. He used a heavy pendulum, and made it vibrate in very short arcs.

There exists evidence however to prove, that an English clock-maker not only applied the pendulum, but constructed a turret clock with one for the church of St. Paul's, Covent Garden (since burnt down) some years before either of the above dates. It seems that an engraved plate was affixed in the vestry-room of the old church, of which the following is a copy:—

"The turret clock and bells of this church were made, A.D. 1797, by Thomas Grignon of Great Russell-street, Covent-Garden, the son and successor of Thomas Grignon, who (A.D. 1740) brought to perfection what the celebrated Tompion and Graham never effected, viz., the horizontal principle in watches and the dead beat in clocks, which dead beat is a part of the mechanism of the turret clock. Thomas Grignon, senior, made the time-piece in the pediment at the east end of this parish church, destroyed by fire A.D. 1795. The clock fixed in the turret of the said church was the first long pendulum clock in Europe, invented and made by Richard Harris, of London, A.D. 1641, although the honour of the invention was assumed by Vincenzio Galilei, A.D. 1649, and also by Huyghens in 1657. This plate is here affixed by Thomas Grignon, of this parish, the son of the above Thomas Grignon, as a true memorial of praise to those two skilful mechanicians, his father and Robert Harris, who, to the honour of England, embodied their ideas in substantial forms that are most useful to mankind."

The elder Grignon alluded to above was a cotemporary and friend of James Ferguson, and one of the first members of the Society of Arts; to which society he presented a regulator in the year 1759, which is yet to be seen at the apartments of the Society in the Adelphi.

(To be continued.)

A FEW WORDS IN DEFENCE OF ENGLISH WATCH-WORK.

BY A MECHANIC.

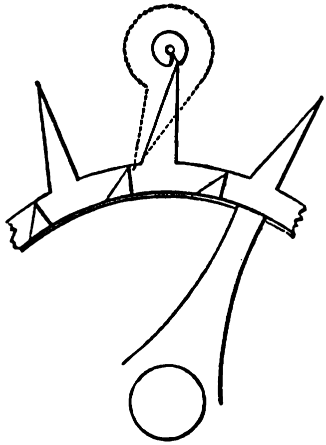
(Continued from page 82.)

Before quitting the subject of horizontal escapements it will be well here to notice a reason which strongly influenced English workmen in seeking other forms of escapement, namely, the complete dependence of the horizontal cylinder upon oil for freedom of action, consequent upon its surface forming the *rest* (as that part of an escapement is

sometimes called) which holds the train of wheels during the interval between each impulse. The point of the escapement-wheel tooth resting and rubbing upon either the inside or outside of the cylinder during the greater part of every vibration of the balance, required constant lubrication, and as the maintenance of the lubricant (oil) uniform either as to quantity or fluidity was impossible, the impracticability of developing this escapement to the point required by the chronometer was distinctly recognized.

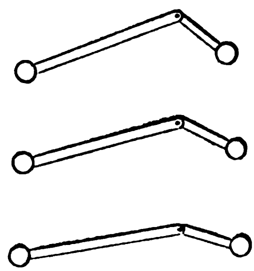
Another escapement, the *duplex*, was greatly influential in establishing a high character for the English watch. This escapement takes its name from the very peculiarity which may be used to describe it, namely, that it is two escapements in one, the smaller one being the release of a locking of the other.

The duplex escapement is formed as follows. The wheel has two sets of teeth—the one a crown wheel, the other a spur wheel; this latter set of teeth locking on a small roller of ruby on the axis of the balance, having a notch down one side to allow the teeth to pass and admit the upright tooth next following such passing tooth to engage and impel an impulse pallet on the same axis; thus—



wherein the said impulse pallet is supposed to be transparent, and the spur or long tooth in the notch just about to escape. This wheel will at once be perceived, although somewhat easier of execution than the horizontal, to be still sufficiently complicated, while if to that be added the minuteness and delicacy of the ruby roller, and the absolute necessity in this escapement for the most delicate accuracy of workmanship, there would appear but little advance made by its contrivance.

The uninitiated may ask, Where is the great delicacy, beyond the making of the ruby roller, in this escapement? *The answer is* found in the fact, that as this escapement gives impulse only in one direction, the whole angle of escapement for the long teeth has to be performed by the balance before the impulse action can be started; hence the great tendency of any external motion, by suddenly reducing the extent of the vibration of the balance, to fail in effecting the said unlocking, which results in the stopping of the watch. This tendency can only be reduced to its minimum by the reduction of the diameter of the ruby roller to the utmost limit of sufficient strength, and also the depth of engagement with it of the long teeth of the wheel; every such diminution in the size of the roller implying a corresponding decrease in the diameter of a part of the balance axle, and each reduction of depth making the pressure of the wheel on the axle so reduced more and more to approximate to the action of the levers in a Stanhope press—the most disadvantageous form possible for pressure in such a case; thus—

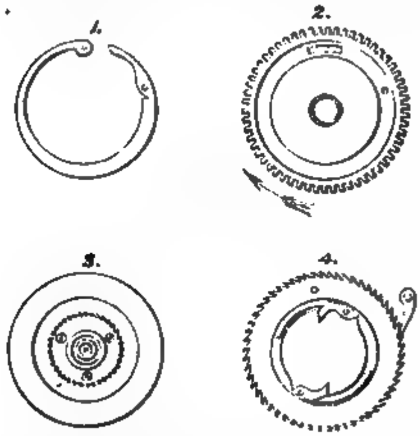


representing pairs of radii of roller and wheel. In each instance the eye will readily perceive the greater power which each successive arrangement has to force the centres of motion apart, and causing the very indispensable freedom of the fine balance pivots in their holes to occasion serious difficulty. Still the performance of this escapement when well executed is so good, that where a close rate was desired it has always been a favourite, provided always that it never got subjected to rough usage, to which its natural delicacy has always been a barrier.

This will be the proper place to recur to the *fusee*, as it was during these gradual developements of the pocket time-keeper that it became necessary to contrive the means of keeping up the motion of the balance during the operation of winding: for each successive improvement of escapements was found to be coupled with a disposition to set, that is, to discontinue impulse on the reduction of motion in the balance; in other words, impulse in these escapements did not begin until the balance was moved a certain number of degrees round, so that the act of winding was pretty sure to stop the watch. Beyond this, the duplex was carried forward

to the nicety that its performance was vitiated by the additional result of the piece retrograding during the act of winding.

The *going fusee* was the result of this necessity, and is constructed as follows:— The click or pall and its spring, which retains the fusee in the place to which it is lifted or wound by the key, is removed from the first wheel and mounted on a thin steel plate interposed between the fusee and the said first wheel, through which and the first wheel beneath it the fusee axle passes loosely, the whole being kept together by a collar of steel fastened to the axle below. The edge of the steel plate is cut into what are called ratchet teeth, that is, short teeth slanting in one direction, thus—



which permit motion in the direction of the natural action of the first wheel, but stop all retrogression. Between this steel plate and the first wheel is placed a flat spring (*fig.* 1), of such strength that the mainspring of the piece can but just bend it up; one end being attached to the steel plate or ratchet, and the other end to the wheel (*fig.* 2), with a *locus* of motion of the free end amounting to about two teeth of the first wheel, the same being determined by a pin moving in a long hole in the wheel, thus—

This spring being constantly bent by the pull of the chain, the force of the spring may be removed for some minutes, its place being supplied by the aforesaid spring with a degree of accuracy of pull proportionate to the nicety of its execution.

The *lever escapement*—the most popular one of the present day from its hardness and ease of execution—is the clock wheel pallets and pendulum reduced to the portable form, by the notable addition of a locking action in the pallets themselves, allowing of complete detachment of the balance during the greater portion of its vibration,—the wearing parts being simple, and therefore easily armed with surfaces of hard stone so as to prevent their wear.

This escapement consists of a wheel having teeth slanting forward, so as to act by their points only; the pallets into which the wheel works resembling exactly the ordinary clock pallet, except that the plane of rest is straight instead of being portions of circles having the centre of action of the pallet as their centres. These planes incline a small quantity backward, and thus give the pallet, by the forward pressure of the wheel, a disposition to hug the wheel, thus effecting the complete detachment of the train from the balance after giving impulse. The impulse given by the wheel when acting on the driving planes of the pallet is transmitted to the balance by a lever (the origin of its name) fastened to the pallets and extending in any direction required to the balance and its roller. This roller is simply a disc of steel carrying a small pin of hard stone, which the lever is forked to receive.

The action of this escapement is as follows:—Supposing the balance to have returned from one of its excursions, by the action of its spring the pin enters the fork; a very small motion of this fork (or lever in which, as mentioned before, it is made) causes the pallet to move from the position in which it locked the wheel into that position in which the wheel falls on to its driving plane, when the lever instantly becomes the driver instead of the driven, and continues to be so until the tooth of the wheel falls off the end of that pallet, and a tooth falls on to the locking plane of the other nib of the pallet. This action is repeated in the opposite direction on the return of the balance from the excursion so set up. Thus—

the angle of escapement being capable of considerable variations to suit the various purposes of wear, adjustment, &c.; and although in consequence of the sliding action of the driving wheel upon the inclined plane of the pallet it is dependent upon oil, the broadness of the surfaces and other little arrangements make it in practice a capital and very manageable escapement.

Recent improvements have been made in this escapement, greatly enhancing its adaptability to the very best sort of pocket watches; but, as their authors are still living, I forbear to speak upon what they might better like to describe themselves.

(*To be continued.*)

PLATES ILLUSTRATIVE OF THE PRINCIPLES OF MR. HARRISON'S TIME-KEEPER.

(*Continued from page* 79.)

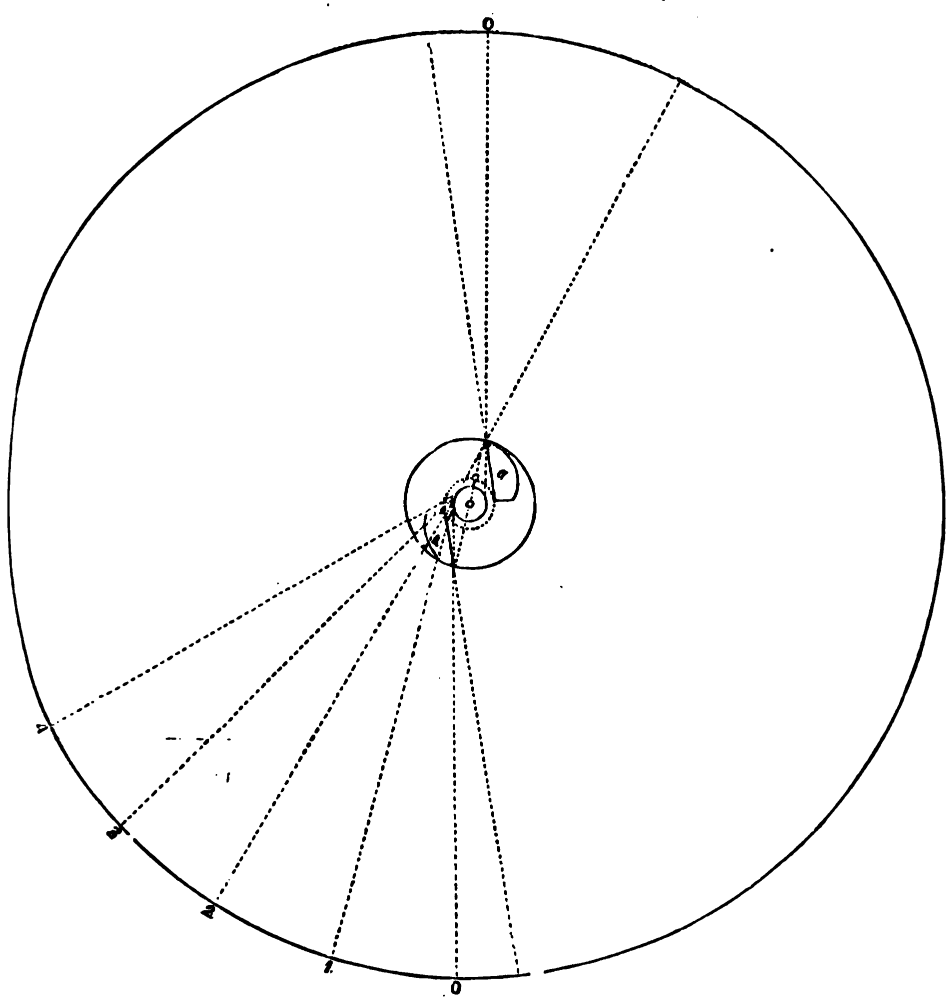
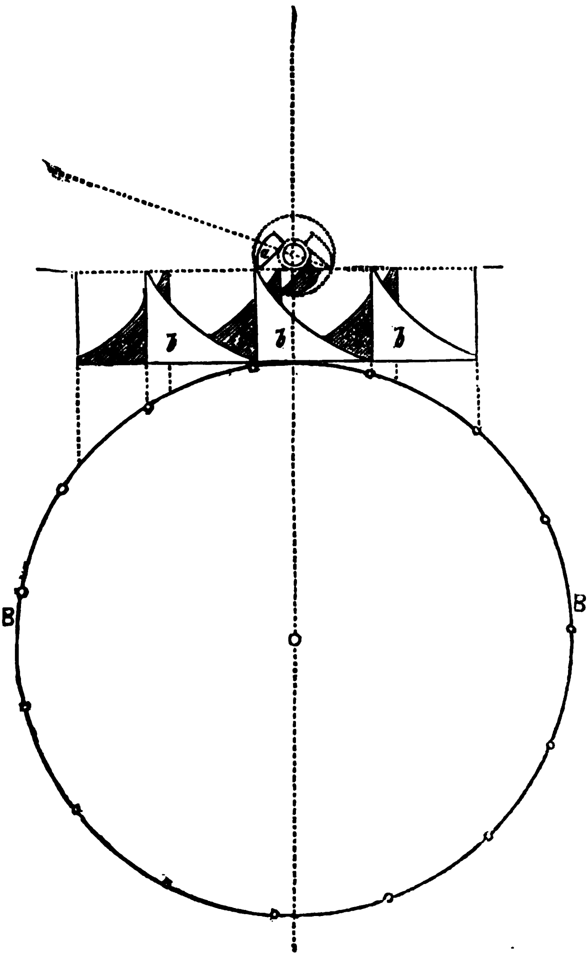


FIG. 8.

a a are the Pallets, of ten times the size that they are in the Time-keeper. The dotted lines from 24ths of the circle, show the power the balance-wheel has to impede the motion of the balance by the declivity on the back of the pallets, at any the same time whenever it shall have the greatest power to give it motion.

Fig. 9.



Is to shew the proportion between the balance, the balance-wheel, the balance-wheel teeth, the pallets, and at what distance the wheel acts from the centre of the balance. A A represents the balance, B B the balance-wheel, *a a* the pallets, and *b b b b b b* the balance-wheel teeth.

THE GOING-BARREL AND THE FUSEE.

To the Editor of the Horological Journal.

Sir,—I perfectly agree with "A Mechanic," that the fusee is a great improvement on the going-barrel; nevertheless, prejudice must not lead us to ignore the advantages of the latter. No watch-maker would put a going-barrel to a chronometer or frame movement, neither would he attempt to introduce a fusee in a watch of the thickness of a crown piece; consequently there must be a point in the heights of movements at which the change from the fusee to the going-barrel beneficially takes place. The public *will have flat watches; and if* we do not make them, they will buy them of foreign construction. I have seen, of late years, three-quarter plate movements much too flat for fusees; there is a deficiency of power in them, and the chains are too thin.

The superiority of the fusee consists in a uniform power applied to the train.

The advantages of the going-barrel are:—

1st. Greater motive power.*
2nd. Greater simplicity.
3rd. Avoiding the friction of the fusee pivots.

Now, to leave principles and come to facts. Some years ago I conducted a series of comparative trials with the fusee and going-barrel;

* This only applies to flat watches.

but having mislaid the papers, I last week took six watches of equal quality, with flat balance springs, duplex and lever respectively scaped, finished, and timed by the same workmen, and I noted the difference of their rates between the first three hours and the last three hours of the twenty-four. The following is the result :—

		1st day.	2d day.	3d day.
A.	Fusee Duplex	0	0	−1
B.	Fusee Lever...........	−1	−1	−0·5
C.	Fusee Lever	−0·5	−1	−0·5
D.	Going-barrel Duplex	+0.5	+0·5	+0 5
E.	Going-barrel Lever ..	−2	0	−2
F.	Going-barrel Lever.	+1	+1	+0·5

This table exhibits the performance of three days, showing how many seconds each watch gained or lost during the last three hours of the twenty-four, compared with the first three. For example: D, a going-barrel duplex, gained half a second more, for three successive days, during the last three hours than it did during the first three. I then continued the trial for three hours beyond the twenty-four, also for the first and last six hours, without any appreciable difference in the result.

It will be remarked, that two of the going-barrel watches gained during the last three hours,—the reverse of what might have been anticipated.

These trials, conducted in perfect fairness, would lead to the supposition that the superiority of the fusee is more apparent than real with regard to the performance of the watch; and, to throw some additional light on the subject, I have translated an article on the going-barrel by M. Henri Robert, of Paris, published in "*La Science*," which I have the pleasure to enclose.

Extract from an Article on the Going-Barrel applied to Nautical Chronometers, by M. Henri Robert.

I now come to consider the irregularity of the force of the top and bottom of the spring, and thence the difference during the first hours of work compared with the last. My predecessors remedied this solely by the isochronism of the vibrations of the balance, by the balance spring. Others had searched, in secret, if there were not a means of introducing in the barrel a change which would produce an equality similar to that of the fusee; they attempted to employ a barrel divided in two in its height, and containing two springs; they pretended thus to obtain a certain equilibrium. Being entirely against these complications, accusing the fusee only of the additional labour that it introduces into the primary construction, and particularly in the work that remains to be done to adjust the piece, I should not think of applying myself to such systems.

If you notice what happens when a barrel is very empty and as you continue winding the spring, directly the exterior turn has quitted the rim of the barrel the spring coils in a spiral, and the radius of the exterior turn of the spiral line becomes shorter than that of the interior of the barrel; by continuing the winding of the spring, the spiral which it forms is more and more retracted, and the radius of the exterior turn becomes gradually shorter. You soon recognize here, as in the fusee, a lever or variable radius which diminishes as fast as the elastic force of the spring augments.

This observation made, it is easy to obtain the advantages resulting from it. It is with the view of obtaining these advantages that I dispose my barrels, arbors, and springs; and experience has proved the excellence of these means.

To render this more intelligible, we must have recourse to figures.

Fig. 1

Fig. 2.

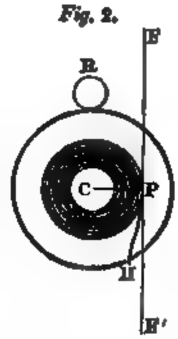


Fig. 1 represents the spring wound at the moment that the exterior turn quits the rim of the barrel; the spring therefore pulls the rim according to the line FF^1, tangent to the curve described by the last turn of the spring at this point; CP is the radius of this curve, P the power, C the point of rest, and R the resistance. The force acts then on the resistance by a lever CP; but when the spring is more coiled, as in *Fig.* 2, it acts on the barrel, always according to the line FF^1, by a lever which is reduced to the length CP, while the distance of R, the resistance, from the point of rest does not change. It is evident that the same thing happens as with the fusee; that is to say, the moment when the last turn of the spring detaches itself from the rim of the barrel, the lever by which the motive power acts diminishes progressively as the elastic force augments.

It results, then, that if you dispose the body of the arbor, the size of the barrel, and the spring in proper proportions, you can compensate the augmentation of the elastic force by the variable length of the lever.

You must particularly notice (and this is what you do not always see at first), that although the point of attachment is at the point H of the barrel, and at a constant distance from the centre, nevertheless the force of the spring acts according to the tangent of the exterior curve which the outer turn of the spring describes, and consequently by a lever equal to the radius of that curve.

It remains to be seen, whether we can arrive at a perfect equality of the force transmitted to the train,

as with the fusee. We will answer on that subject what a very clever English constructor, Mr. Charles Frodsham, said in the halls of the Exhibition (1855) before several horologists, when we were contesting with him the perfect adjustment of the fusee. He said, "that a perfect adjustment of the fusee did not trouble him at all; that he only required an approximation, and a free development of the spring." And, in fact, the most clever constructors have all their fusees of the same curve, and do not alter them to suit the spring; and as for us, we should find it difficult to believe him who affirmed that he cut each of his fusees to each spring, for the adjustment he might get to-day would not do in six months.

With the going-barrel I have many times repeated the experiment of comparing a piece during twenty-four hours every third hour, without finding any difference worth remarking.

I am, Sir, your obedient Servant,
CORNHILL.

P.S. In reply to "Vertical" I beg to say, that his difficulty may be overcome by making the dials of silver and depositing a coat of aluminium by the electro process. Clock dials, barometers, &c., might be made of brass. *Vide* Society of Arts Journal, Feb. 4th.

PROTECTION FROM RUST.

To the Editor of the HOROLOGICAL JOURNAL.

Sir,—I beg to avail myself of your columns to make a suggestion to my brother chronometer-makers; and am emboldened to do so by the manner in which you appear to give publicity to whatever may tend to the advancement of our art.

For many years past I have observed that, under favourable circumstances (or perhaps *unfavourable* would be the word employed by the sufferer) watch-work shows a disposition to rust with a rapidity which I can only conceive due to the galvanic circuits formed by its various metals &c. in the presence of moisture.

Now, it has struck me that similar circuits might be made by arrangement to serve useful instead of noxious purposes, if designed, instead of occurring as it were by accident, somewhat in the same way that Sir Humphrey Davey protected the copper sheathing of ships' bottoms—namely, by keeping in contact with the parts most vulnerable, and which it is most desirable to preserve from rust, some much more highly oxydizable metal.

I therefore beg to suggest that the pendulum spring should in future be pinned in with *zinc, or*—what would perhaps be better—a *boss or lump of zinc slipped* on the balance staff in contact with the collet. This might possibly act as a protection (more or less perfect) from that rust which is so fatal to this spring. At any rate it can do no harm, which is more than can be said of every prescription including new or untried medicines, while it possesses the agreement of a well-recognised philosophy.

Your's, respectfully,
GNOMON.

EXHIBITIONS AND PRIZES FOR COMPETITION.

To the Editor of the HOROLOGICAL JOURNAL.

Sir,—Some months since I addressed a letter to you, as the organ of the British Horological Institute, which you kindly inserted, but which has as yet elicited no reply.

The Council of the British Horological Institute have promised us, amongst other things in their capital bill of fare, to promote emulation amongst the real artists by exhibitions and prizes for excellence or originality. As a manufacturer, conscious of the necessity for a thorough knowledge of the art if there is to be any hope of success beyond the mere production of goods on established models, I have from time to time felt the advantage that might be derived by stimulating novelty—not the irregular suggestions of mere eccentricity, but designs directed by some original proposition, such as manufacturers might well defray the expense of, and workmen be pleased to compete for.

I shall mark my sincerity in this matter by assuring you, Mr. Editor, that whenever the Council of the Institute shall have made their arrangements for the purpose, I will myself propose a subject, and place in the hands of the Council the conditions and the amount of the premium to be given; and I feel certain that many of my brother manufacturers will come forward in a similar way.

Your's, respectfully,
A MANUFACTURER.

APPLICATION OF ELECTRIC CURRENTS TO ORDINARY CLOCKS.

To the Editor of the HOROLOGICAL JOURNAL.

Sir,—In common with many others, I have to thank you for the interesting account of the Liverpool system of synchronous indications of time by means of public clocks.

The results are, doubtless, very desirable; but I think that the plan used is hardly of a

nature to warrant us in saying that if the current does not pass, the ordinary time-keeping properties of the clock would not be injured.

The plan described makes the bob of the pendulum a hollow coil of wire, which vibrates over certain permanent magnets.

Now it is a fact well known to electricians, that an induced current will be produced in a coil so situated. In fact, this forms the principle of the magneto-electric machine, which produces currents of electricity without the use of a voltaic battery.

The effect of this induced current would be, to bring the pendulum under a governing power which we know to be extremely variable, producing as a necessary consequence a varying rate in the clock. But, even if the permanent magnets were removed, we should still have the magnetism of the earth to deal with, and it would be found that the position of the plane of vibration of the pendulum with respect to the earth's axis would affect its performance.

I am, your's obedently,

POLARIS.

DECIMALS. No. 4.

(*Continued from page* 83.)

After what has been said in the three preceding articles we hope we are justified in presuming that our young readers (to whom these articles are more particularly addressed) will have no difficulty in following us through this portion of our last endeavour to convey to them in a simple and familiar way a knowledge of that portion of arithmetic which forms the stepping-stone to almost all calculations in the science and practice of mechanics. We well remember our own unaided efforts to acquire a knowledge of those principles which in these articles we have attempted to communicate to others. We cannot forget the apparent anomaly which presented itself to our minds when we found that by multiplying two or more numbers together we had for the product a number less than either, and when by dividing one number by another that the quotient should actually be greater than the number to be divided. A little patience, however, and thought soon overcame the apparent contradiction, and we became deeply impressed with the necessity which exists for expressing all general rules in terms which shall be equally applicable to all the cases to which such rules are intended to apply. With the foregoing facts forcibly impressed upon our memory it was that we made the remarks upon the term *multiplication* in our last. Similar remarks are equally applicable to the present portion of our subject, viz., the *division* of decimals. When one number is to be divided by another, the term *division* in its ordinary acceptation implies that the number to be divided is the greater of the two; but this is not always the case. Presuming that our readers understand the terms *dividend*, *divisor*, *quotient*, and *remainder* to mean respectively the number to be divided; the number by which we divide; the number of times or fractional parts of a time that the second is contained in the first; and that number which remains after the divisor has been taken out of the dividend any definite number of times or fractional parts of a time, we proceed with our explanation.

If we wish to divide any given number by another—say, for instance, 16 by 4, or by 2, or by 1, what is it we seek? The answer is plain,—to discover how many fours, twos, or ones there are in 16, and the quotients tell us there are 4 fours, 8 twos, or 16 ones in that number. But when we divide by a decimal, say •5, we seek to find how many times •5 (which is equivalent to ½) is contained in the number 16, and the quotient will be more than 16—it will, in fact, be 32. If we divide the same number 16 by •1 (one-tenth), the quotient will be 160, there being 160 tenths in 16; so that for every division by a decimal only we have an increased quotient.

Again, let us divide •7 (*decimal seven*) by the whole number 7: here the divisor is ten times greater than the dividend, and it would appear ridiculous to require a novice to tell how many times the number 7 is contained in a number ten times less than itself; but what we really require is, not what portion of •7 (7 tenths) is the number 7, but what is the 7th part of •7 (7 tenths), and the answer is •1 (one tenth), as exhibited in Example 1.

(Ex. 1.)

$$7)\ \cdot 7 \over \quad \cdot 1$$

The actual process in the division of decimals is precisely the same as in that of whole numbers, after having attended to the following precautions: First, whenever there are decimal figures in the divisor, and the dividend contains none, or a less number than there is in the divisor, ciphers must be added to the decimal part of the dividend till the number therein equals or exceeds the number in the divisor. Secondly, the division must always be carried on till the whole of the decimal figures or ciphers in the dividend have been made use of; after which there should be pointed off from the right hand of the quotient as many places for decimals as

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multiplied by 3·1416 — gives ·0558506+ as its area, and which it will be seen is one-ninth of ·502656+, the area of the barrel.

The space unoccupied by the arbor will therefore be eight-ninths of the whole barrel or ·446805+; and half of it (·223402+) the area occupied by the spring.

The area of the barrel (including that of the arbor), after subtracting the space occupied by the spring, is (·502656 — ·223402+) ·279253+; and, by the reverse of the rule for finding the area, the radius will be found to be ·29814. Thus,

Area = R^2 × 3·1416 —

Radius = square root of area divided by 3·1416+ And

the square of ·279253+ divided by 3·1416+ is ·29814+, the distance from the centre of the barrel to the inner turn of the spring; and by deducting the radius of the arbor (·1333+) is ·164809+ the distance from the arbor to the inner turn of spring when unwound and in the barrel.

By subtracting from the radius of the barrel (·4) the distance from the centre of the barrel to the inner turn of the spring (·29814+) it will leave ·1018576+ as the thickness of the (13) coils of the spring, and by dividing by 13, will give the thickness of the spring ·0078352+.

The area occupied by the spring was found to be ·223402+, and the thickness ·0078352+; the length will therefore be (·223402+ divided by ·0078352+) 28·512694+ inches.

Note. + after the decimals signifies that there is some remainder.

E. B.

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2. *The same answered by* H. F.

According to the question, ·8 is the diameter of the barrel, and $\frac{\cdot 8}{3}$ = ·266666 &c., the diameter of the arbor; and, by the well-known rule for finding the areas of circles from their diameters, we have (·8^2 × ·7854)= ·502656 of an inch as the area of the barrel, and $(\frac{\cdot 8}{3})^2 \times \cdot 7854$ or $\frac{\cdot 64 \times \cdot 7854}{9}$ = ·0558507 nearly as the area of the arbor, which is one ninth the area of the barrel, and being subtracted from the area of the barrel leaves eight ninths of the said area for the areas of the space between the arbor and spring, and of the part occupied by the spring; and these two being equal will each be equal to four ninths of the area of the whole barrel, viz. $\frac{\cdot 502656 \times 4}{9}$ = ·22340266 &c. of an inch.

As the whole of that part of the barrel contained within the inner turn of the spring comprises the two areas, viz., that of the arbor one ninth and that of the space between it and the spring four ninths, and therefore occupies five ninths of the whole area of the barrel, consequently (by Euclid, Bk. 12, Prop 2, viz., that the areas of circles are as the squares of their diameters) we have the following proportion: As $\frac{1}{9} : \frac{5}{9} :: (\frac{1}{3})^2 : 5\ (\frac{\cdot 8}{3})^2$ Or, as $1 : 5 :: \frac{\cdot 64}{9} : \frac{5 \times \cdot 64}{9} = \frac{3 \cdot 20}{9}$ the square of the diameter of the entire portion within the spring; and $\sqrt{\frac{3 \cdot 20}{9}} = \frac{\sqrt{3.20}}{3} = \frac{1 \cdot 7885}{3}$ = ·596166 of an inch, the diameter of the said portion, and $\frac{\cdot 502656 \times 5}{9}$ = ·2792533 &c. its area.

Subtracting the last-named diameter from that of the barrel, we have ·8 — ·596166 = ·203834 for that portion of the diameter occupied by the spring, of which there being 26 thicknesses we have, by dividing this diameter by 26, thus $\frac{\cdot 203834}{26}$ = ·00784 of an inch nearly, for the thickness of the spring; whence we have, by dividing the area of the spring by the thickness, viz. $\frac{\cdot 22340266\ \&c.}{\cdot 00784}$ = 28·5 inches for the length; and lastly, by subtracting ·26666 &c. from ·596166, we have that portion of the diameter which is occupied by the space between the arbor and spring, which is ·596166 — ·26666 = ·3295 of an inch.

The following therefore will be the diameters, areas, &c. of the various parts; those required by the question being marked with an asterisk :—

	Diameters.	Areas.
1. The arbor	·266666	·0558507*
2. Space between the arbor and spring	·3295*	·22340266
3. Portion occupied by the spring	·203834*	·22340266
4. Whole space within the spring	·596166	·2792533
5. The barrel	·8	·502656
6. Thickness of spring	·00784*	
7. Length of spring	28·5*	

GREENWICH TIME-BALLS.

To the Editor of the HOROLOGICAL JOURNAL.

SIR,—The erection of time balls or semaphores is now becoming a matter of much importance in our principal towns or seaports. I think you or some of your contributors would render a great service if you could enlighten your readers a little upon their construction, and the most improved means now adopted with respect to their management. I am, Sir, yours &c. TIME.

QUESTIONS FOR SOLUTION.

Question No. 3. *By* Geometricus.

The diameter of the main wheel attached to a going barrel is ·764025 of an inch, taken across the extreme points of the teeth; the number of teeth in the wheel is 84; the breadth of the teeth and spaces are supposed to be equal; and the distance of that part of the tooth which acts upon the pinion is half the thickness of the tooth from the extreme point. On applying a balanced adjusting rod when the spring had been wound up four turns, I found that it required a weight of one ounce and a half troy to be placed on the rod at six inches from the centre of the barrel to keep the spring in equilibrium. I wish some of your juvenile correspondents would inform me what is the actual pressure upon the centre pinion at the point of its contact with the tooth of the wheel. Geometricus.

Question No. 4. *By* Vibratio.

Required the length of brass necessary to compensate for the expansion of a rod of steel of sufficient length to construct a pendulum consisting of a bar of steel of uniform thickness (without a bob) which shall make 100 vibrations per minute. Vibratio.

TO CORRESPONDENTS.

We wish it to be clearly understood by our readers, that we do not hold ourselves responsible for the views advocated by our Correspondents, but, at the same time that we offer a fair field for discussion, we exercise the privilege of our office in judging whether the subjects are of a nature suited to the objects of our Journal.

Declinations of the following Stars, and Times at which they are on the Meridian at Greenwich, for March, 1859.

Name of Star.	Day of Mon.	Dec. South °	′	″	Time of passing the Meridian. h.	m.	s.	
a Canis Majoris (*Sirius.*)	2	16	31	38·9	7	58	39·85	P.M
	12	16	31	39·6	7	19	20·59	„
	22	16	31	40·1	6	40	1·33	„
a Hydræ	2	8	2	67·1	10	39	57·23	P.M
	12	8	2	68·1	10	0	38·10	„
	22	8	2	69·0	9	21	18·95	„
		Dec. North						
a Geminorum (*Castor.*)	2	32	11	42·8	8	45	12·80	P.M
	12	32	11	43·4	8	5	53·57	„
	22	32	11	43·9	7	26	35.34	„
β Geminorum (*Pollux.*)	2	28	21	51·1	8	56	16·03	P.M
	12	28	21	51·7	8	16	56·74	„
	22	28	21	52·2	7	37	37·57	„

EQUATION OF TIME TABLE
For March, 1859.

Day of the Week	Day of Mnth	At Apparent Noon — Equation of Time to be *added* to Apparent Time. m.	s.	Difference for One Hour. s.	At Mean Noon. — Equation of Time to be *subtracted* from Mean Time. m.	s.
Tues..	1	12	37·93	0·499	12	38·03
Wed ..	2	12	25·95	0·519	12	26·06
Thurs.	3	12	13·48	0·539	12	13·59
Fri. ..	4	12	0·55	0·558	12	0·66
Sat. ..	5	11	47·16	0·577	11	47·27
Sun. ..	6	11	33·31	0·594	11	33·42
Mon...	7	11	19·04	0·611	11	19·16
Tues..	8	11	4·37	0·628	11	4·49
Wed...	9	10	49·29	0·644	10	49·41
Thurs.	10	10	33·84	0·658	10	33·96
Fri. ..	11	10	18·03	0·672	10	18·15
Sat. ..	12	10	1·90	0·685	10	2·01
Sun. ..	13	9	45·45	0·698	9	45·56
Mon...	14	9	28·69	0·710	9	28·80
Tues..	15	9	11·66	0·720	9	11·77
Wed ..	16	8	54·38	0·729	8	54·49
Thurs.	17	8	36·86	0·738	8	36.97
Fri. ..	18	8	19·16	0·745	8	19·26
Sat. ..	19	8	1·27	0·752	8	1·37
Sun. ..	20	7	43·21	0·758	7	43·31
Mon...	21	7	25·04	0·762	7	25·13
Tues..	22	7	6·75	0·765	7	6·84
Wed ..	23	6	48·36	0·768	6	48·45
Thurs.	24	6	29·92	0·770	6	30·01
Fri. ..	25	6	11·45	0·771	6	11·53
Sat. ..	26	5	52·95	0·771	5	53·02
Sun. ..	27	5	34·46	0·770	5	34·53
Mon...	28	5	15·99	0·768	5	16·06
Tues..	29	4	57·56	0·765	4	57·62
Wed ..	30	4	39·19	0·762	4	39·25
Thurs.	31	4	20·89	0·759	4	20·95

*** *All Communications for this Journal should be addressed to the* Editor, *at the Office*, 35, Northampton Square, Clerkenwell.

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WHAT IS HOROLOGY?

(Continued from page 90.)

Early History of Clocks—*continued.*

Huyghens' Cycloidal Pendulum and Maintaining Power.

The conflicting evidence which we have thus adduced with respect to the first inventor of the pendulum clock may serve as another instance, among many afforded by the history of science, in which it is extremely probable that different minds were, independently of each other, arriving at the same results.

Among the first who applied the pendulum to timekeepers, Christian Huyghens, to whom we have already alluded as having written a treatise on the subject, was undoubtedly the one who did the most to publish his investigations and experiments, and is therefore the one to whom the science of horology is the most indebted. This philosopher soon discovered that vibrations of unequal lengths were not equal in their times, and that consequently if the vibration was increased in extent the clock would lose, and the contrary. When first applied, the pendulum was merely an elongation of one arm of the balance, the verge being placed in a horizontal position, and a contrate wheel being introduced into the train to give motion to the scape wheel. This form may still be found in old crown wheel clocks. This construction produced oscillations of extremely variable lengths, resulting in an equally variable rate of performance.

Huyghens found that this defect was essential to a circular path, and that a pendulum, in order to be perfectly isochronous, must vibrate in a curve which is known as a *cycloid.* The effect of this would be to lift the weight towards the end of each vibration, causing its path to be steeper there. The cycloid is a peculiar curve, of which we may get a notion if we suppose a point to project from the extreme edge of a cart wheel. If the cart be placed so close to a wall that the point will mark it, and be then moved onward, it will be seen that the point has a motion compounded of the straight-lined motion of the cart and the circular motion of the wheel, the resulting curve being called a cycloid. This curve may also be drawn approximately on a slate by taking a disc of wood of any convenient size, and a pencil tied in the centre of a piece of string. A single turn of the string being taken round the disc, the two ends should be fastened firmly to the two opposite sides of the slate frame. If the pencil be now taken in the hand and moved onward, it will revolve with the disc as it rolls along the string. The point being pressed on the slate gives the required curve. (See *fig.* 18.) We may

Fig. 18.

remark, that it is important to get a tolerably clear idea of a cycloid, in order to understand other matters to which we may have to allude in the course of these papers.

The manner in which Huyghens endeavoured to give the required curve to the motion of his pendulum was exceedingly ingenious. The clock to which it was applied is a good illustration of a step in advance in horology. *Fig.* 19 is a view of it in profile.

Fig. 19.

A A, B B, are two plates placed vertically. They were six inches in height, and two inches and a half broad, and were connected together by four pillars placed at the angles. The height of these pillars was one inch and a half. The first wheel, C, has 80 teeth, and is $2\frac{1}{2}$ inches in diameter; it carries a pulley, D, the groove of which is armed with steel points, to prevent the cord to which the wheel is attached from slipping. The wheel C drives the pinion E, of 8 leaves, on the arbor of which is the wheel F, of 48 teeth, driving the pinion G, of 8 teeth, and the contrate wheel H, of 48 teeth. This acts into the pinion I, of 24 teeth, having on its arbor the

escape wheel K, of 15 teeth. N Q, and P, are two cocks fixed on the plate B B. The extremities, N and P, of the two cocks carry the pivots of the verge L M, and the projecting part Q is traversed by two holes—one large, to admit the staff of the verge to pass through without touching, and the other at right angles to the first, and smaller, to receive the pivot of the scape wheel K. The verge carries two pallets of the same kind and at the same angle as those before alluded to in De Wick's clock. The part M carries the fork S, which embraces the rod V V of the pendulum V X. It is the suspension of this pendulum that constitutes one of the two distinctive features of this clock, it being especially contrived to give the peculiar cycloidal motion which Huyghens had found was necessary to isochronism. It is shown in perspective at *fig.* 20, and consists of two

Fig. 20.

cheeks of brass carefully bent in a cycloidal form. The pendulum was suspended between these by means of two parallel cords of silk. At each oscillation these wrapped round the cheeks, and lifted the pendulum so as to cause it to describe the required curve.

This exceedingly ingenious invention did not, however, answer by giving practically a closer rate. A pendulum connected with a clock and kept in motion by it is in a very different condition from one which is vibrating freely. It is no longer governed by laws which solely apply to it, but is also influenced by others attaching to the mechanism by which it is actuated. The condition of the air as to dryness or moisture would also affect the strings whereby the pendulum was suspended, and would cause more or less adhesion to the surface on which they pressed. This construction has therefore not been adhered to. It may here be remarked that the spring suspension for pendulums as used at present produces an approach to the cycloidal path by shortening the pendulum in a minute degree at the extreme of the oscillation, and therefore has a tendency to equalize the vibrations. For this reason a regulator which acts immediately upon the spring is disadvantageous in pendulums as in balances, because it affects the isochronous properties of the spring, which vary with its length.

Seconds were indicated by this clock, an engraved plate being affixed to the prolonged pivot of the contrate wheel, as shown at *f f*.

The second important improvement consists of an arrangement whereby the clock was kept going forward while being wound. It is known as "Huyghens' pullies," and is shown at *fig.* 21. Two weights, P *p*, are

Fig. 21.

employed, the smaller one being merely to keep the cord on the stretch. The cord is an endless one, the two extremities being joined together. It is first passed over the pulley and attached to the great wheel C (*fig.* 19), from whence it comes down, passes round the pulley *d*, supporting the larger weight P, is carried upwards, and passes over the ratchet pulley H, which turns on a stud fixed to the inside of the back plate of the clock frame. From this pulley the cord comes down and passes under the pulley *f*, supporting the counterpoise *p*, which gives sufficient tension to the cord to prevent its running round the pulleys without turning them. The ratchet pulley H has a click to prevent its turning backward, and will therefore only turn by pulling down the cord at *m*, which operation raises the main weight P. This weight therefore exerts half its force in turning the wheelwork, *minus* half the weight of the counterpoise, and is constantly pulling upon the pulley D, even when in the act of winding.

This maintaining power is the first, and by no means the worst that has been devised. It would be easy to mount the pulley H with a square quite independent of the clock frame and dial, which would be a great advantage in regulators and astronomical clocks for observatories, as the winding pulley might be placed in any convenient position and the key applied in the usual manner.

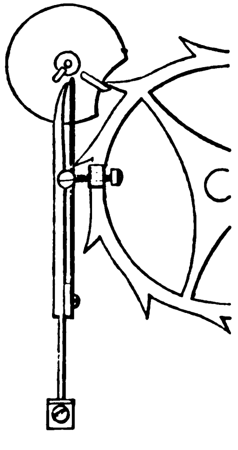
A FEW WORDS IN DEFENCE OF

ENGLISH WATCH-WORK.

BY A MECHANIC.

(*Continued from page* 93.)

The next and last escapement that it will be necessary to describe is the *detached*, equally well-known as the *chronometer escapement*, from being the one always now employed for marine chronometers in consequence of its fulfilling the conditions necessary for permitting the full development of the properties of the vibrating balance, which with its spring is the real time-measuring portion of the machine.



This escapement consists of a wheel having simple pointed teeth slanting forward in the direction of the wheel's motion. These teeth engage a roller, or impulse pallet, on the balance axle; this roller being half the diameter of the wheel, and having a notch which forms the point of impulse. The wheel is locked by a spring, called the *detent*, which passes from a distant point on the frame of the watch just below the level of the wheel to near the centre of motion of the balance. At the point where it passes the tooth of the wheel last but one past the roller, and therefore in fifteen teeth representing a tangent to that radius of the wheel most nearly capable of being moved in and out, that is to say, towards and from the centre of the wheel, by motion derived from the balance axle,—in a line with that radius this spring or detent carries a piece of ruby, which projecting upward between the teeth intercepts the motion of the wheel. The part of this detent most distant from the balance is reduced in thickness until it is thin enough to bend with ease—in fact, is left so thin that it only possesses power to return to its point of action quick enough to follow safely the motions of the balance and wheel. Attached to one side of this detent, namely, that side nearest the centre of the wheel, is fastened a slender spring of gold, rather longer than the detent measured from the part to which it is attached to its end, and therefore projecting a trifle beyond it. The detent is worked by a small piece of ruby fastened in a very small roller on the balance axle immediately below the large or impulse roller, as follows:—Supposing that the balance be now put in motion,—moving in one direction, it merely lifts the end of the gold spring out of its way in passing (it is therefore called by some the *passing* spring), but on returning it lifts the whole detent bodily, of course unlocking the wheel, a tooth of which enters the notch in the great or impulse roller properly placed to receive it, giving an impulse to the balance—quick—central, and so far resembling a blow that no oil is found necessary, and therefore free from the difficulty its use always implies.

Although this escapement has taken longer to describe than others, it will be perceived to be an escapement of the utmost simplicity of parts – namely, wheel, pallet, and bolt—for such in fact the detent is; and although this escapement demands and obtains the very highest degree of careful workmanship, the more it is studied the more forcibly the notion of simplicity forces itself upon the mind. Its action being the reduction of sliding action to the lowest possible point, its connection with the balance effecting the greatest possible amount of detachment, and therefore offering the least possible amount of disturbance to the free motions of the same, while the force necessary to unlock or discharge the wheel bears so trifling a proportion to the force of the train that it is quite unfelt, and leaves the student in chronometry in possession of a balance so free, that he is untrammelled by most of the mechanical difficulties that beset his path previous to its invention.

We here leave the purely mechanical part of our subject, arriving at that point when the contemplation of principles constantly accompanies our movements.

The Isochronism of properly arranged Pendulum Springs.—This is no invention, but a discovery; and could we trace back and note the number of times the fact presented itself to the observation of working watchmakers without being perceived, some useful lessons might possibly result.

To describe what this isochronism is, it will aid us if we go back and explain, that a pendulum vibrating in a circular arc appears to be perfectly equal in the time it takes to vibrate, whatever be the length of such vibrations; but, if minutely watched, such will not appear to be the case, the long vibrations occupying more time than the short, shewing that gravitation is not sufficient in the circular arc to produce perfect isochronism unaided. But it has been proved, that if the pendulum be made to vibrate in a cycloid the time of vibration is perfectly equal. But the mechanical part of this problem is by no means easy with the pendulum, in consequence of the small arc over which for other reasons it is usual to make it move. Now, in the watch or chronometer the pendulum spring plays the part of gravitation to the balance, returning it to its quiescent position, or rather swinging it to and from on either side of that point until friction &c. brings it to a state of rest; and it has been found by experiment that in every spring of sufficient length a certain part of it possesses the property of accumulating force in the exact proportion required to correspond with the angular motion of the balance, so as to return it in the same time as if it had been of any other number of degrees, and that is what is termed *isochronous*, or equal-timed.

(To be continued.)

COMPLETE SPECIFICATIONS OF PATENTS. No. I.

JOHN ARNOLD.

Complete Specification of the Patent granted, April 27th, 1776, *to* John Arnold, *of the Adelphi Buildings, for* "A New Pendulum Spring for Timekeepers, and the Method of Compensating the Effects of Heat and Cold of the Same."

After the usual preamble, the specification proceeds to describe the invention as "composed, made, and performed" in the following manner, that is to say—

"*By means* of an helical or cylindrical spiral *spring, which is represented* in the annexed

Fig. 1.

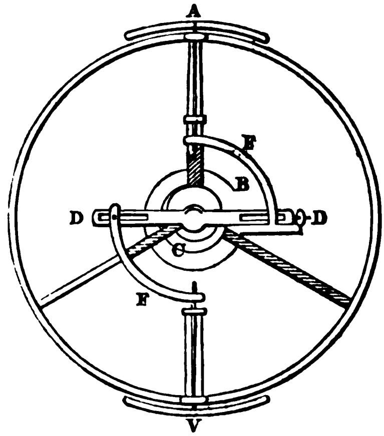


Fig. 2.

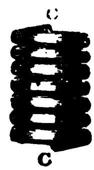


fig. 2, and which spring is made by winding a straight lamina of steel round a cylinder, and on which it is hardened and tempered. In that state it is fastened to the balance at C (as represented in the annexed *fig.* 1) vertically, and the other end is fastened to the cock. The compensation for heat and cold is in the balance; and on the under side is affixed a spiral, B, as represented in *fig.* 1, which is composed of two metals, brass and steel, the inner end of which is screwed to the collet of the verge; the other end hath a small hole in it, into which the pivot of lever D, in *fig.* 1, is inserted. A A, in *fig.* 1, are two segments of circles that are combined with the lever D, by means of the arms F, F, in *fig.* 1, and made to approach the centre of the balance in hot weather, and to recede from it in cold, by the expansion or contraction of the spiral B; by which means the resistance of the balance is always equal to the tension of the spring.

"N. B.—The said invention is applicable to timekeepers for the pocket or otherwise.

"Jno. Arnold. (L.S.)

"*April 7th*, 1776."

The Council of the Horological Institute have effected a correspondence with the *Société des Horlogers* of Paris, and intend to exchange a copy of each number of this Journal as issued, for one of the French publication, the "*Revue Chronometrique.*" The back numbers of the latter periodical for the present year have already been received.

APPLICATION OF ELECTRIC CURRENTS TO ORDINARY CLOCKS.

To the Editor of the "Horological Journal."

British and Irish Magnetic Telegraph Company, Limited.—Secretary's Department.
2, Exchange Buildings, Liverpool.
March 21, 1859.

Sir,—In this month's number of your valuable Journal I observe a letter, signed "Polaris," on the subject of Mr. R. L. Jones's improved method of regulating clocks by electricity which has been brought into public operation here by Mr. Hartnup, of the Liverpool Observatory, in connection with this Company.

"Polaris" appears to have misunderstood the character of the improvement, and need not be under any apprehension of irregular induced currents arising to interfere with the rate of clocks so regulated.

The regulation is effected by *continual* currents of electricity being passed from the clock at the Observatory to the pendulum bob of each clock it is required to control, and the motion of each pendulum is thus kept in exact accordance with that of the Observatory pendulum, the latter by this arrangement checking the other clocks whenever they have the least tendency to deviate.

It is only in case of an injury to the conducting wire—a case rarely happening—that the public clocks lose the constant control of the Observatory clock and have to depend upon their own rates of going; and their performance even during such short interval would not be liable to disturbance by any action of induced currents generated by the motion of the bobs of their pendulums over the small permanent magnets employed.

These remarks will also apply to the suggested interference of terrestrial magnetism.

As a proof I may mention, that the public clocks controlled from the Liverpool Observatory have now been kept to true time for several years with voltaic power of the feeblest kind. One of the clocks regulated—that in the tower of our Town-hall—used formerly to keep exceedingly bad time, and give much trouble; but since this simple and inexpensive alteration has been made, it works with the utmost exactitude, and, except occasional winding, requires no attention whatever.

This clock has four faces, and is very heavy both in works and striking apparatus, yet a single voltaic cell with very weak solution is quite sufficient to insure a thorough control.

The difference between Mr. Jones's improvement and other applications of electricity to clocks is simply this, that in other arrangements the clocks have either been—

1. Driven altogether by electricity, which under such circumstances is the motive power. This plan requires enormous batteries, and is quite inapplicable to large clocks.
2. Released by electricity, which under such circumstances acts as the detent of the clock. In this plan the separation of the conducting wire stops the going of the clock, and for this reason, and from the fact that a large consumption of electric power and great nicety of adjustment are required, this method is objectionable, and not applicable to turret clocks.
3. Occasionally regulated by electricity. I need scarcely say that this plan falls far short of what is needed to secure correct time; especially since turret clocks, from the heaviness and size of their works, from the exposure of their hands to the action of the wind, and from other causes, are more liable to error, and, as a rule, I believe give worse time than any others. In fact, to check with any certainty upon this plan from a distance, it becomes necessary the clock should be kept going with a known character of error—say, fast—until the period of regulation comes round.

The improved method, on the other hand, is readily applicable to all turret clocks, and it matters very little indeed whether they are well or badly made, as the coarsest description of works may be brought under control with ease.

The Company have found the method so advantageous as regards the exact regulation of time, that they have decided to apply it to a large public clock to be placed in the tower of the Company's new building in Threadneedle Street, opposite the area of the Royal Exchange. The regulation will in this case be effected by means of an observatory clock, as at the chief offices of the Company in Liverpool.

I am, Sir, your's obediently,
Edward B. Bright, *Secretary.*

COMPENSATION BALANCE.

By M. J. Gundina.

(From the Revue Chronometrique.)

At the meeting of the Industrial Class (Society of Arts, of Geneva) on the 8th of last December, Professor Colladon read a paper by M. J. Gundina, of which we give the following extract.

" We know that when we wish to effect compensation for temperature in the balance of a watch, the rim is made of brass and steel in such a way as that the brass shall be outside and the steel inside, the latter expanding less than the other.

" This arrangement, however, is insufficient in cases of extreme temperature. Several skilful horologists are applying themselves to perfect the method of compensation ; and it is towards this end that M. Gundina has directed his labours, and he hopes to have attained it by means of the new balance which he presents to the class.

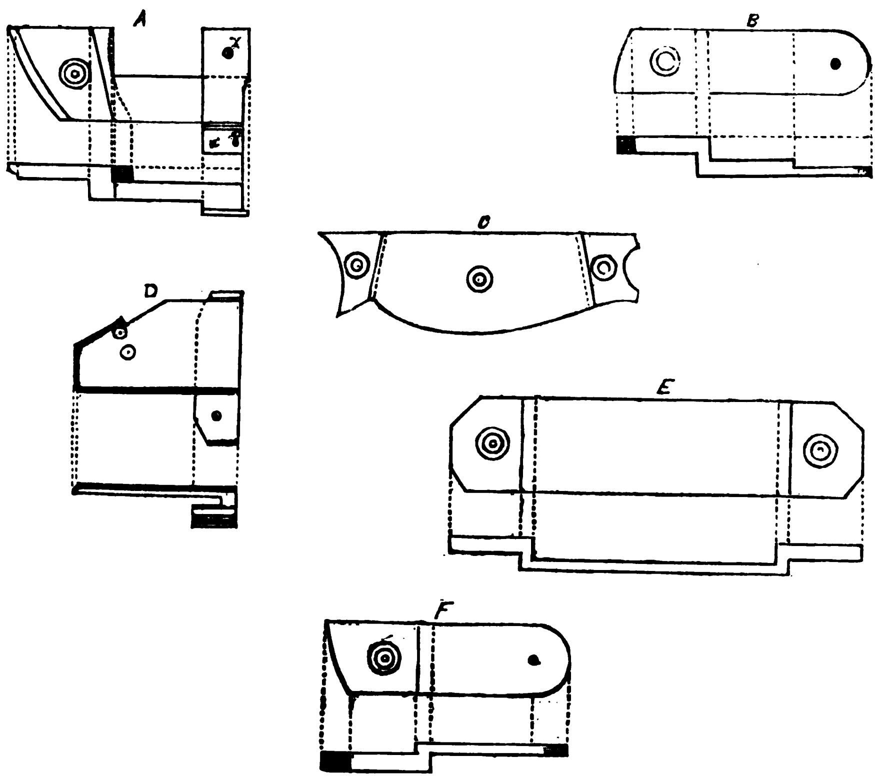
" This new balance is composed of four laminæ, each composed of one-third steel and two-thirds brass. Two of these plates (for the primary compensation) are maintained in their concentric form by their being joined to the two supplementary laminæ. By this arrangement the form is not changed, whatever may be the extremes of temperature in which the movement may be placed."

[We must confess we cannot understand the above description; but as the memoir was thought of sufficient importance to be printed, perhaps some of our correspondents can enlighten us.—Ed. H. J.]

PLATES ILLUSTRATIVE OF THE PRINCIPLES OF MR. HARRISON'S TIME-KEEPER.

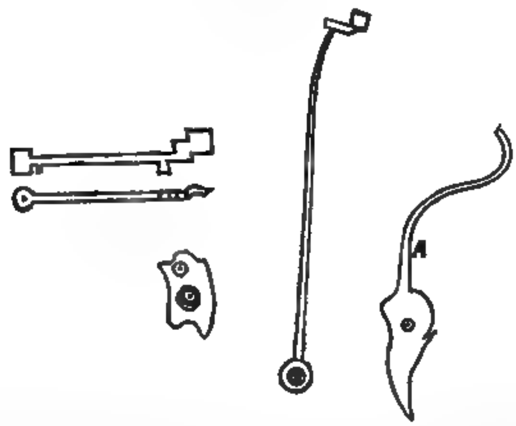
(*Continued from page* 94.)

Fig. 10.



A is the Counter-potence, with the follower *a*, and a small screw at *c*, to stop when at its proper place, and *x* is the centre of the fourth wheel.
B is the cock for the minute-wheel.
C is the steel bridge.
D is a cock for the contrate wheel.
E is a cock at the first wheel.
F is a cock at the contrate wheel on the pillar-plate.

Fig. 11.



Is the Dittent [Detent], which is to stop the balance before the watch be down. It turns upon a centre at *t* in Figure 14. A is the locking-spring.

Diameter of the Hole in the Socket (its wider end) about	0·0475	of an inch.
Diameter of the Upper Pivot	0·055	„
Diameter of the Lower Pivot . . .	0·0225	„

Fig. 12.

A

A A represents the upper plate. B B the balance.
a a the thermometer.
b b the balance-spring.
c c slider to adjust the thermometer end-way.
d the stud.
e the artificial cycloid.
f a piece to adjust it so as to bear properly against the spring.

FIG. 13.

a a a a a the feet of the brass edge.
b b the ratchet at the spring barrel.
c the click.
d d d d the cock at the end of the first wheel.
e e a ratchet.
f f the centres of the two clicks which act in it.
g g the two springs that act at them.
h h h h h h the six pillars of the frame.
i i the steel bridge.
k k k two wheels that carry the seconds, one being on the contrate wheel-arbor, the other moving on the cannon-pinion.
l the cannon-pinion.
m m the minute-wheel.
n the hour-pinion.
o o the hour-wheel.

British Horological Institute.

INAUGURAL DINNER.

We announced in our last number that this event had just taken place, but so closely upon our day of publication that we were compelled to defer the report of the proceedings till the present number. We now give a corrected account of what took place on that interesting occasion. When first proposed, it was imagined that the dinner would be confined to a comparatively small number of members, but the interest excited was so great that nearly three times as many gentlemen as were first expected signified their intention of being present. The chair was occupied by VALENTINE KNIGHT, Esq., supported by the other Trustees of the Institute, by the members of its Council, and also by many visitors, as well as by so great a number of members that other rooms had to be prepared for their accommodation.

After the cloth was drawn, the usual loyal and complimentary toasts having been proposed and received with enthusiasm,

The CHAIRMAN proceeded to say, that the next toast was one in which they all felt deeply interested, —"Horology and its allied Sciences." He hardly knew any science which could be placed on an equality with horology. As to mechanical science, he would undertake to say there was none. He did not know how society, from the highest to the lowest, could possibly well go on without a watch or a clock. They might take the crowned head, the minister of state, the financier, the man of business, the lover, or any character they pleased—without the means of reckoning time, where would they be? He thought he could

answer—nowhere. There was no man, whether familiar with the manufacture of a watch or not, who must not feel the deepest interest in its mechanical construction; and he (the Chairman) believed that a great improvement would yet be made in the manufacture of that beautiful scientific work. The claims of the Horological Institute were, therefore, exceedingly well founded, and he trusted that every member of the trade would reap its advantages, from the joint-finisher to the chronometer escapement maker. Other countries might have carried the science of horology to a great extent; but it would be a disgrace to Clerkenwell to be second to any nation under the face of the sun in that art. Mr. Knight then illustrated the necessity of progress in watchmaking from the well-known instance of the Coventry ribbon weavers, who, adhering to their old modes of manufacture, upon the opening of the ports after the war and the consequent competition of the French, were driven out of the trade; but, rallying their energies, and adapting themselves to the altered circumstances, they so far improved their designs as to be able to produce, during the Great Exhibition, specimens of their manufacture superior to those of any other part of the world.

The toast was drank with loud applause.

The Chairman then proposed "Clerkenwell and its Mechanics." He had had the pleasure of knowing that district for the last fifty years, and he felt a deep interest, respect, and love for it. He coupled the toast with the name of Mr. Brooks.

Mr. Brooks felt considerable diffidence in rising for the first time to address so large an assemblage of Horologists on such an important sentiment, as he was not aware till that day that he should be expected to take part in the proceedings. However, the subject was a wide one, upon which much might be said. He thought he might state with confidence there were few among Clerkenwell mechanics who were not attached to the locality in which they earned their livelihood, especially if they were successful in obtaining by their exertions a competency. Clerkenwell had hitherto been more sinned against than sinning. It had been termed by some "the black spot of the metropolis," but those who thus designated it had forgotten the diamonds it possessed. Clerkenwell had been looked upon as a great "ragged school;" but the persons who thus regarded it had overlooked the wealth and talent it contained as the seat of manufacture of much that was useful and ornamental. Did they ask for a proof, he answered, Look at our jewellers and jewellery. Where would they find such skilled mechanics in that line of manufacture, or such massive and brilliant jewellery, as were to be found in Clerkenwell? Did they require beautiful machinery, could any surpass that which Clerkenwell produced? Did they point to Horology, the trade they were more immediately connected with, there was not a spot in the world inhabited by civilized man which did not possess some proof of the manufacturing superiority of Clerkenwell. There was not a place in the habitable globe where some of its handiwork had not passed over to, as the companion and monitor of the Navigator, Traveller, and Philosopher. There was not a part of the earth where, if a difficulty was to be overcome in the science of horology, it was not sent to Clerkenwell, with the confident expectation that it would be unravelled. Let them not tell him that the Clerkenwell mechanics had degenerated in character. To those who made the assertion he would reply, "Give them fair prices, and whatever had been manufactured here or elsewhere they would produce again in equal excellence." Did any one ask whether Clerkenwell mechanics were worthy of sympathy; let them look at their benevolence, as was evidenced in their "Pension Society," as one example only, the parent of all similar institutions existing in the metropolis. Clerkenwell mechanics had been too long neglected, but he trusted that through the assistance of the Horological Institute they would hereafter be properly appreciated, that they would more rightly estimate their own dignity, and be henceforth acknowledged as more worthy of the approbation of the world than they hitherto had been. He was not speaking of them as a class, because, as a body, the Clerkenwell mechanics at the present time were amongst the most industrious and intelligent of the working men of this kingdom; but yet there were some among them who, it must be confessed, they could have wished had been better taught, and whom they could desire to have seen better educated in the principles of morality. To them the Institute held out the hand of friendship, and said, "Come with us, and we will endeavour to raise you to the standard we wish Clerkenwell men to attain." He trusted that the establishment of the Horological Institute would be a new birthday to a state of greater excellence and prosperity for the Clerkenwell mechanics. (Cheers.)

The Chairman then gave the toast of the evening, —"Success to the British Horological Institute." (Cheers.) He had a gentleman in his eye to whom the trade were under deep obligation—Mr. Hislop—and whom he would therefore call upon to respond to the toast.

The toast was drank with enthusiasm.

Mr. Hislop felt great pleasure in responding to the toast on the part of the Horological Institute, but in doing so he expressed his conviction that the Council had made a mistake in their selection of a representative. ("No, no.") They might have found some one better acquainted than he was with after-dinner speeches to advocate the claims of the Institute. He did not pretend to the possession of that persuasive eloquence which could draw assistance from the listeners, of whatever kind that assistance might be required to be. On the present occasion they had specially to consider what had been done by the Institute, and what it hoped to do in the future. Although he felt himself placed at a disadvantage in addressing them after what had passed, yet there were one or two facts which might be referred to in connection with the Institute, which would give them hope as to the future. They all knew its history. It was but a few months since it was established in that room, at a meeting held under the presidency of their present Chairman. There was no denying, that the British Horological Institute had become an established fact. It did not follow that they had not enemies, even up to the present time; or perhaps, more correctly speaking, that there were not persons who did not understand their objects, and therefore were not friendly towards them. If he was asked the question, "Of what use is the Horological Institute?" he must confess that he should be rather puzzled for a reply, because it seemed to be a question which answered itself. If they inquired abstractedly whether it was important that, in order to become successful in business, they should understand the principles of their trade, and be able to turn their hands to any particular demand which might be made upon it in the course of business, they would all answer that it was. That was one of the objects which the Horological Institute was calculated to effect. It was intended to furnish every man with that scientific knowledge which should enable him to understand the principles upon which the art of horology was based—the scientific rules upon which every machine must be constructed—and those various modifications which they must be enabled to comprehend before they could be successful as mechanics. They might indeed be mere machines; but they knew very well that mechanics should be something better than that. One object, therefore, of the British Horological Institute was to make the operative watchmakers, not of Clerkenwell only, but of every district who chose to belong to it,

better instructed and more intelligent, and consequently superior mechanics to what they were at present. Without detaining them upon that topic, he might notice one or two benefits which, as an Institute, they had accomplished. They had established the "Horological Journal," which had reached its sixth number, and the circulation of which was daily increasing, and the demand for which had compelled the reprint of several of its issues. That was an established fact. They had also been able to get a house over their heads. They had commenced the formation of a Library, of books of a scientific character useful to horologists. Many volumes had been given, others had been lent, and the Council had reason to hope that they should be able greatly to increase the number. They had also various propositions under consideration, the adoption of which they hoped would largely augment the success of the Institute. But they must recollect—a fact which he wished to impress upon the mind of every gentleman present—that if the Institute was to succeed it must be by the assistance of the Trade itself. It might be all very well upon its first commencement to look to a certain few individuals to arrange plans and to work out details, but those gentlemen could not carry it on for ever. The Institute must be permanently supported by the knowledge and mental energy of the trade generally. The Council were happy to say that the prejudices against the Institute were fast disappearing, and that many of the mistakes which were made in its earlier days respecting its objects had since been corrected. Many members of the trade who at first opposed were now coming to join them, seeing that their motives were not, as those gentlemen once supposed, selfish, but rather intended for the benefit of the whole trade. With respect to what the Council could do in the future, much of course must depend upon the means which were placed at their disposal; but one chief element of their success was periodical meetings of the members, that they might be able to know each other, and understand each other's wants; for if ever there was a business in which it lay in the power of members to help each other, it was that of the watchmakers. There was none which he knew of—and he thought he knew a little of the principles of many—which depended so much upon certain abstract truths, or occult studies if he might so call them, as horology and the various businesses connected with it. Amongst other instrumentalities for improvement, they proposed to have periodical meetings for discussing questions connected with horology. He hoped the day might never come when the members of the Institute would allow their discussions to be diverted from scientific subjects connected with their trade into questions of social and political economy. They had also announced in the prospectus, as one of the means of instruction adopted by the Institute, Scientific Lectures. The only reason why they had not yet been delivered was the want of a sufficiently capacious lecture-room. A few days since, without saying anything to his colleagues in the Council, he thought it desirable to ascertain whether they could obtain lecturers. The result of enquiries among a few private friends of his own had been a promise of eighteen gratuitous lectures from eminent gentlemen upon scientific subjects closely connected with and belonging to horology:—four on Applied Mathematics, by a Bachelor of Arts of the London University; four on Astronomical Instruments, including the Transit, by a Fellow of the Royal Astronomical Society; and ten on Mechanics, by a Watchmaker. That list, which might hereafter be increased, was an illustration of a fact which he wished to impress upon their minds, namely, that none of them knew what they could do till they tried. It had been said that *the Institute could not* afford to pay for many lectures, *but they did not require to do so*, because they could get them for nothing; and as for those to which he had referred, he could answer for a large proportion at any rate being of a first-rate character. The details of whatever was done in that respect must be a subject for subsequent consideration. Their commencement must of course be small; but if, as they proceeded, they found their rooms overflowing, they must take larger ones, as the Institute increased in number of members and became more flourishing. He must confess that his own views in connection with the Institute extended somewhat beyond the mere abstract principles of horology; he wished to see it pre-eminently the Watchmakers' Scientific Institute. He believed that an intimate connection subsisted between all sciences, and he could easily prove it. If they wished to excel in any particular department of manufacture, they must understand a great deal of the whole. The man who knew most of a business generally would be most likely to succeed best in any particular branch of it. At one time who would ever have supposed that electricity had anything to do with watchmaking? Who would have imagined some forty years ago that the circumstance of Oersted of Copenhagen making experiments with a compass needle and a voltaic battery would have led to the application of electricity to the transmission of time signals, which should be true to the three-thousandth of a second in many miles. Yet that was done three or four times a day in connection with the Royal Observatory at Greenwich. They might thus see how the sciences were connected with the objects of the Institute, and they should endeavour to understand them better by studying them intimately, and by remembering that as mechanics they were something more than machines, and that they had intellects given to them for their use. He would not detain them with any further dry details, which rather belonged to a scientific lecture than to a festive occasion. Before he sat down there was a duty which he might very appropriately conclude his remarks by performing, and that was by proposing the health of a gentleman who from the very beginning of the Institute had evinced the most lively interest in its welfare, and who had aided it not only by his exertions and influence, but also in a more tangible form. Whenever he had had occasion to confer with him on the business of the Institute, he had not only found in that gentleman a ready listener, but one who from his position as well as inclination was also a wise counsellor. He had great pleasure in proposing the health of their respected Chairman, Valentine Knight, Esq.

The toast was drunk with loud and prolonged cheering.

The CHAIRMAN hardly knew how to thank the meeting for the kind manner in which they had received the toast. He felt it was quite undeserved. ("No, no.") He was proud to find seated by his side his esteemed friend Mr. Adams, whom he regarded as one of the oldest members of the trade. He (the Chairman) should have been guilty of bad taste had he not received in the kindest manner he was able to do the deputation who did him the honour of waiting upon him to ask him to join them in furthering that excellent Institute. He did not know any two gentlemen for whom he felt higher respect, from the experience he had had of them in connection with the Institute, than his friends Mr. Hislop and Mr. Johnson. (Cheers.) He believed that the trade was deeply indebted to them, and he was quite sure that the watch and clock makers could not do better than support those gentlemen in carrying out their excellent ideas with reference to the Institute, an association which was wanted for the honour of the country and the trade, to enable it to flourish as it ought to do; and he was sure that through its means watchmaking would prosper. Although he considered himself an outsider

of the trade, he should be happy at all times to give all the assistance to it which lay in his power, not only by personal attendance at its meetings, but by subscribing to its funds, and assisting in causing it to prosper to the extent which it so highly deserved. He felt deeply interested in horology, and had a high respect for every man connected with it, and he should always feel pleasure in meeting them upon such happy and convivial occasions.

The CHAIRMAN then proposed the health of the Trustees of the Institute.

Mr. THOMPSON returned thanks for himself, Mr. Knight, and Mr. Adams, who would all be happy to perform any duty connected with the trusteeship which might devolve upon them. In his early days he had felt very forcibly the necessity of such an Institution, and he was glad to see that it had been so well supported, and was producing such beneficial results. The highly intellectual speech of the Chairman of the Council (Mr. Hislop) was prognosticative of much future benefit to the Institute; and he was glad to find so capable a mind presiding over their deliberations. For himself he must say, that he felt he was somewhat out of place as one of the Trustees, as he thought it was a position that should have been given to some older member of the trade; still he would endeavour to do his duty to the best of his ability. He desired much to see co-operating with them more of those who stood naturally at the head of the trade, and thought that as it was a young Institution there would be no derogation of dignity by such support being sought for; at the same time he wished not to be misunderstood when he said, that it was not altogether men of wealth or long standing who were best able to lead, but rather men with vigorous minds capable of grasping scientific subjects, and able to render them simply for the benefit of their fellow-men. He was pleased to see so many Swiss and German gentlemen connected with their trade present, and would take this opportunity of thanking gentlemen of those nations domiciled among us for the kind assistance they were ever ready to afford to the different charities connected with their trade, and to assure them that as horology was a science of universal import, so they would find that the doors of the British Horological Institute would be open to all, whether he were Greek or whether he were Hebrew. He felt proud to be associated as Trustee with their worthy Chairman, who was always anxious to promote every good work within the trade both with his presence and his purse, and also with Mr. Adams, the honoured representative of an honourable house; and he was only sorry that they did not possess for coadjutor one more worthy than his humble self.

The CHAIRMAN proposed the health of Mr. Johnson, the Treasurer, and the Officers of the Institute. (Loud and prolonged cheering.) He was gratified to hear that handsome response to the name of Mr. Johnson, because he was deserving their greatest consideration. He (the Chairman) did not know a more energetic and deserving man than that gentleman. He would venture to say, without fear of contradiction, that the longer he was connected with the trade of Clerkenwell, the better would he be appreciated by it.

Mr. JOHNSON said, he was bound to take a share of what some might think trouble, but what he regarded as the labours—which were not always trouble—of the business of the evening. Whether the Council of the Horological Institute had done well in making him their mouth-piece remained to be seen. For himself, he had great doubts about the matter. He should, however, use his privilege as, in Parliamentary phraseology, "an independent member." He believed, however, that they were so much one in feeling, that his colleagues would be ready to endorse almost any thing he said. The task of replying to this toast had been taken out of his hands by Mr. Hislop, than whom a more able, pleasant, and industrious coadjutor no man in the pursuit of a public object was ever blessed with. They might think him (Mr. J.) rather paradoxical in saying that he augured well for the success of the policy of the present Council, because mankind were never so happy in their arrangements, or so successful in their contrivances, as when they closely copied the admirable models by which a beneficent Nature had surrounded them. Now he fancied he detected the source from whence they derived the inspiration of their policy in the science of ornithology. There was a species of bird, of the genus *anser*, which emigrated northward at certain seasons of the year in vast numbers. Their flight was exalted, or high in the atmosphere. By a curious instinct, they decreased their aggregate labour by arranging themselves in the form of a wedge, the oldest and strongest bird being placed at its point, so that its well-seasoned pinion was the first to cleave the keen northern blast which they had to encounter. From these facts in natural history he drew the following analogy to the Institute government. The ground taken by the Council, or in other words its flight, was high, whereby it gained a more extended view over the country they had to traverse, and held themselves aloof from those petty jealousies and superstitions which formed the atmosphere of the lower strata,—ignorance. What ultimate shape their flight might take remained to be seen, but at any rate it closely approximated to the form he had indicated, for they had, as they (his hearers) might see, thought proper to thrust the *greatest goose* to the front. (Laughter, and cries of "No, no.") Mr. Hislop had kindly explained what the Institute had done. It had established a Reading-room; but he feared that its Council had a heavier work before it in finding a reading community. Although horologists might be literary men, they were not, as the Council could desire to see them, a reading body. No disgrace, however, attached to them on that account; for watchmaking was an art which employed the brain as well as the fingers to such an extent that a man rose from his daily labour exhausted, and without an appetite for reading. Hence the great hope of the Institute was to instruct by appealing to the eye and the ear, by lectures and the exhibition of models, which would stimulate to further inquiry through the medium of books. He would yield to no man living for keenness of appreciation of the power possessed by this art of raising man socially, morally—aye, and even politically. It possessed the power of converting that labour, which had been called the primeval curse of man, into the purest and most lasting pleasure—a pleasure renewed every day of his existence. But he had discovered that he certainly was not the man to advocate its cause ("Yes, yes,") for he was wanting in the marvellous faculty of being "all things to all men." He was convinced by daily proof that there was some truth in the assertion, that he was "*rude of speech*." ("No, no.") Shakspearian as was the attack, so should the reply be Shakspearian. "I do speak simply as mine understanding instructs, and as mine honesty bids me put it into utterance." (Cheers) Did ability but second inclination, then would he make that very night an epoch in horology; but, wanting that, he asked his brother councillors, in thanking the meeting for the kindness with which they had drank their healths, to endorse a request, to which he would allude directly. They certainly acted together for the interests of the art to the very best of their ability; and the proof of some little success he might lay before them, in the fact that they had a continual accession of non-horologists to their members. Science was universal; horology was so fascinating, that there had scarcely ever appeared a great physical philosopher (he was not speaking of abstract men who buried themselves simply in mathematics, although even they would not form much of an exception) who did not dabble a

little in horology. Nay, there were connected with the science of horology men who might never yet have been heard of by them. The history of watchmaking, unfortunately, up to the present time had been a history of isolated efforts; a connected record of it had yet to be written. Amongst the members of the Horological Institute they had men who had achieved for themselves a connection with horology by skilled mechanical contrivances, and by high scientific attainments. Help was needed from such men, and help most likely would be rendered by them. There were two notable instances at present existing of men who had connected themselves with that science, who now formed part of the Institute. Mr. Hislop had alluded to the connection of electricity with horology. One of the earliest members of the Institute was Mr. Whitehouse, the projector of the Atlantic Telegraph, whose name would be carried down to posterity, from the fact of his having demonstrated that to be practicable which a vast number of the savans of this country remained for years in doubt of—namely, the power, without injury to the conductor, of transmitting electric signals over very great distances. But by quiet demonstration that gentleman proved its practicability; and if the undertaking with which he was at that time connected was a partial failure, at any rate his achievements served as new starting points in the science, which would lead to the ultimate success of that telegraph. Mr. Roberts, of Manchester, was also alluded to, and instances adduced whereby, through him, as a member, the Institute was connected with machines the study of which might benefit the art. The officers of the Horological Institute would make the best possible use of the means placed at their command. In deprecation of the false estimate which the meeting might form of the intention and wishes of the Council, he might say for himself—because in that instance they might not need to pray to the meeting on their own account—that ancient as well as modern physiognomists had enunciated the fact, that long-continued practice in vice or virtue affected the characteristic marks on the human countenance; and for that reason he begged them to judge lightly when he asked them, in the words of the poet,

> "If to my share some trifling errors fall,
> Look in my face and you'll forget them all."

(Roars of laughter.) Mr. Johnson then made an appeal in behalf of the funds of the Institute, which was responded to by the meeting to the extent of nearly £100.

The Chairman proposed the health of the Swiss and German gentlemen to whom Mr. Thompson had alluded, coupled with the health of Mr. Klaftenberger.

Mr. Klaftenberger, in returning thanks for himself and the foreign horologists resident in the metropolis, said that he had been a watchmaker all his life with all his heart and soul, and he considered that no man could be a true horologist unless he did so. The Chairman had referred to the case of the Coventry ribbon manufacturers. Certain trades had been advanced in this country by the competition which had been brought into them. Clerkenwell, whatever had been said to the contrary, was pre-eminent in watchmaking. Breguet was one of the greatest watchmakers; we are indebted to him for a great number of inventions and improvements, and the present house still keeps up its reputation by its superior work; but he denied that they made chronometers superior to those made in this country. England had produced, among other celebrated watchmakers, Graham, Earnshaw, and Arnold—men who stood highest in the trade. Breguet adopted a system, and was supported in it as few men ever will be, so far as mere watchmaking is concerned. He procured all the most clever men who were able to do his work—it did not matter where they came from. Hooker was one of the first workmen in this country; Breguet secured him and other men of superior talent, and thus was enabled to do what he had done. But there were men in England who had not the support which Breguet received, but who, as regarded time-keeping, produced greater work than he did. He (Mr. K.) appreciated every man who produced good work; but he never gave a man less on that account, but, on the contrary, more. It was not true, as some persons had alleged, that Switzerland stood higher than England in watchmaking. England could produce as cheap as Switzerland, except in the 15s. and 20s. articles, which were mere toys. The art of watchmaking was to produce a watch keeping proper time, and that had been done no where so well as in England. There was in that room a workman, Mr. Cole, who was a second Breguet; no man in the trade had done more than him. He would conclude by proposing the health of all the watchmakers in this country. (Cheers.)

The Chairman read two letters of apology for absence—one from Mr. Charles Frodsham, who said that he had advocated the formation of such a society for the last 20 years, and had referred to it in his work on "The Isochronism of the Balance Spring;" and the second from Mr. Atkins, Clerk of the Clockmakers Company, of Cowper's-court, regretting his inability to be present at the dinner.

The Chairman then proposed the health of Mr. De Pecca, whose instrumental and vocal abilities had greatly delighted the company during the evening;—a toast which was drank with loud applause.

The health of Mr. Brown and the non-horological members, and of Mr. Stirling Coyne and the visitors, were severally drank and responded to.

The Chairman proposed the "Clockmakers' Company," which had rendered the Institute most important service. He would, in connection with the toast, propose the health of a leading member of that corporation, Mr. James Adams.

Mr. Adams had peculiar pleasure in responding to that toast, proposed as it was by his oldest acquaintance and friend, Mr Knight, whom he had known from his childhood, at a period when the charitable institutions of Clerkenwell required support, and who was then, as he had ever since been, ready to aid them. It was satisfactory to look on the past benevolent efforts of the trade for the relief of its decayed members; but how much better it would have been if, by a course of horological training, they had been placed in such a position that they would not have required that help. Many of the members of the trade were now recipients of its bounty, who, had there been such an Horological Institute in their youth, might have raised themselves above eleemosynary aid. The Clockmakers' Company had granted the use of their models and works on horology to the Institute, and he hoped they would yet do more in its behalf. As a corporation, that company had powers which it would be ridiculous to attempt to enforce by law—that of coming into a shop and destroying all bad work. The object of the Institute was to prevent such bad work being made. He trusted the day would not be far distant when every member of the clock and watch-making trades would join the Institute.

The Chairman gave "The Press," which was responded to by Mr. Farmer, and the meeting separated.

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

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(*Continued from page* 98.)

1773, July 22.—No. 1048.

SMALL, William.—A method of constructing timepieces, "the simplicity of which depends upon "employing sectors or racks, or levers, instead of "wheels, scapements instead of pinions, roughened "circumferences instead of teeth, fixed studs or pins "instead of axes, circles with Vernier's divisions "instead of hands, and occasionally centrifugal "hydraulic machines instead of ballances." The pendulum is mounted upon an axis, the extremities of which are cylindrical, and rollen surfaces so curved that the vibrations are nearly isochronal: the number of wheels and pinions is lessened by substituting sectors or levers for the former, and scapements for the latter. The scapements are fixed to the sectors or levers, and deriving a reciprocal motion from teeth or pins in other wheels or sectors, or in bars or pieces of other forms, communicate reciprocal motion to the sectors. In some cases the scapement is moved only in one direction by the clock, and is returned back by its own weight, or by a spring. For slow or irregular motions, or unequal or large portions of time, roughened circumferences of wheels, or sectors, are used. Instead of hands, revolving circular plates, with Vernier's or Nonius's divisions, are used.

[Printed, 3*d*.]

1775, December 30.—No. 1113.

ARNOLD, John.—" A new pendulum spring for "timekeepers, and the method of compensating the "effect of heat and cold of the same." A helical or cylindrical spiral spring, made by winding a straight lamina of steel round a cylinder, on which it is hardened and tempered, is fastened to the balance vertically. The compensation is in the balance, and on the under side is affixed a spiral, composed of two metals, brass and steel, the inner end of which is screwed to the collet of the verges; the other end has a small hole into which the pivot of a lever is inserted. Two segments of circles are combined with this lever, by means of arms, and made to approach the centre of the balance in hot weather, and recede from it in cold, by the expansion and contraction of the said spiral.

[Printed, 5*d*. See Rolls Chapel Reports, 6th Report, p. 163.]

[*** The complete description of this patent, with plates, is given at page 104 of the Journal; and we intend to adopt a similar course with such others as we deem of sufficient importance.—Ed. H. J.]

1780, March 18.—No. 1249.

RECORDON, Louis.—A watch which winds itself up. A weight of silver is so placed inside the watch as to be in equilibrium when in a horizontal position, being sustained by a pivot, on which one end works, and by a spiral spring. The motion of walking disturbs the equilibrium, and the weight is thrown up by the spring against a spring placed above the weight, which latter spring causes the weight to descend again, and the motion thus continues. The weight by this process acts, by means of wheels, on the barrel, and thus winds up the spring of the watch. A little mechanism prevents the watch being overwound, and also throws off the operation of the renovating part when the watch hangs up at rest.

[Printed, 9*d*.]

1782, January 1.—No. 1311.

TYRER, Thomas.—" Horizontal scapement for a " watch to act with two wheels, being a new and very " great improvement on horizontal watches."

[No Specification enrolled.]

[*** This is one of the originals of the duplex escapement.—Ed. H. J.]

1782, April 15.—No. 1324.

MORLEY, Hildebrand.—A machine to give to mills, clocks, &c. a constant motion. Consists of a large wheel having divisions on its rim, like a water wheel, each large enough to contain a round wooden or hollow metal ball. This is connected by pullies with a smaller wheel, which drives a third wheel, to which are attached lifters. As the large wheel revolves, thereby causing the others to revolve, the balls fall off, and rolling down an inclined plane or spout, enter a tall square tube filled with quicksilver or some fluid, and, from their lightness, rise to the surface, and are lifted out by the lifters, and then roll down another inclined plane or spout, and reload the large wheel There is also a small wheel attached by spokes to the rim of the large wheel, and thus kept in motion. The machinery is fixed to a framework.

[Printed, 3*d*]

1782, April 15.—No. 1325.

MORLEY, Hildebrand.—Somewhat similar in character to the last. A string, with one of the balls at one end and a small weight at the other, passes over a pulley, attached to a dial, whereon the twelve hours are unequally marked, and turning on the same axis as the hour hand. The ball floats on the surface of water in a tube. There is a small hole in the tube, through which the fluid flows gradually, unequally, and slowly, and as the ball sinks the pulley turns round, and the hand points to the hour.

The pulley and dial may be dispensed with, by having a belt with the hours and subdivisions marked on it, stretched out alongside the tube, which is made of glass. As the fluid sinks, it shows the hour on the belt.

[Printed, 3*d*.]

1782, May 2.—No. 1328.

ARNOLD, John.—The tooth of the balance wheel is an epicycloid; the part of action in the pallet on which it acts, is a straight line from the outer edge to the center of the verge. The scape wheel rests on a

single spring, whilst the balance is vibrating, until it is unlocked to add new impulse to the balance. The ends of the helical spring are incurvated, to render the expansion and contraction of the spring perfectly concentric with the centre of the balance or verge. The balance is adjusted by two pieces of compound metal, placed in particular ways, for compensating the effects of heat and cold.

[Printed, 5*d.* See Rolls Chapel Reports, 6th Report, p. 141.]

1782, November 15.—No. 1342.

MORLEY, Hildebrand. — A timepiece whereby the time is shown by the fall of sand, from the head of the timepiece, through a very small hole, into a chamber, in which is a peculiar valve, through which the sand passes, and falls into a tube having a glass side or front, and having a band stretched alongside, with figures properly marked thereon, to show the hours and quarters. The air is allowed to escape from the tube into the head by a pipe. The valve is made with either a single or double fall; and the sand passes through as soon as there is sufficient in weight on the single fall to overbalance the resistance of a small weight, and in the case of the double fall, when the weight on one fall overbalances the other. A similar timepiece acts by means of mercury instead of sand.

[Printed, 9*d.*]

TO CORRESPONDENTS.

Duplex and Polaris shall appear in our next.

We wish it to be clearly understood by our readers, that we do not hold ourselves responsible for the views advocated by our Correspondents, but, at the same time that we offer a fair field for discussion, we exercise the privilege of our office in judging whether the subjects are of a nature suited to the objects of our Journal.

Declinations of the following Stars, and Times at which they are on the Meridian at Greenwich, for April, 1859.

Name of Star.	Day of Mon.	Dec. South °	′	″	Greenwich Mean Time of passing the Meridian. h.	m.	s.
α Hydræ	1	8	2	69·5	8	41	59·76 P.M
	11	8	2	69·8	8	2	40·55 „
	21	8	2	69·9	7	23	21·33 „
α Virginis (*Spica*)	2	10	25	45·2	0	38	28·10 A.M
	11	10	25	45·9	11	59	9·11 P.M
	21	10	25	46·3	11	19	50·08 „
		Dec. North					
α Leonis (*Regulus*)	1	12	38	68·6	9	22	5·73 P.M
	11	12	38	69·0	8	41	47·55 „
	21	12	38	69·6	8	3	27·34 „
α Bootis (*Arcturus*)	2	19	54	43·9	1	32	0·53 A.M
	12	19	54	45·0	0	52	35·12 „
	22	19	54	46·4	0	18	9·66 „

EQUATION OF TIME TABLE
For April, 1859.

Day of the Week	Day of Mnth	At Apparent Noon — Equation of Time to be *added* to Apparent Time. m.	s.	Difference for One Hour. s.	At Mean Noon. — Equation of Time to be *subtracted* from Mean Time. m.	s.
Fri. ..	1	4	2·68	0·754	4	2·74
Sat. ..	2	3	44·59	0·749	3	44·64
Sun. ..	3	3	26·62	0·743	3	26·66
Mon...	4	3	8·78	0·736	3	8·82
Tues ..	5	2	51·10	0·729	2	51·13
Wed...	6	2	33·60	0·721	2	33·63
Thurs.	7	2	16·28	0·713	2	16·31
Fri. ..	8	1	59·16	0·704	1	59·18
Sat. ..	9	1	42·25	0·695	1	42·27
Sun. ..	10	1	25·57	0·684	1	25·59
Mon...	11	1	9·16	0·673	1	9·17
Tues..	12	0	53·01	0·661	0	53·02
Wed ..	13	0	37·14	0·649	0	37.14
Thurs.	14	0	21·57	0·635	0	21·57
Fri. ..	15	0	6·32	0·621	0	6·32
		subtracted from Apparent Time			*added* to Mean Time.	
Sat. ..	16	0	8·58	0·606	0	8·58
Sun. ..	17	0	23·14	0·590	0	23·14
Mon...	18	0	37·31	0·574	0	37·31
Tues..	19	0	51·07	0·557	0	51·09
Wed ..	20	1	4·43	0·539	1	4·44
Thurs.	21	1	17·36	0·520	1	17·37
Fri. ..	22	1	29·84	0·501	1	29·85
Sat. ..	23	1	41·86	0·481	1	41·87
Sun. ..	24	1	53·40	0·461	1	53·41
Mon...	25	2	4·46	0·440	2	4·47
Tues..	26	2	15·02	0·419	2	15·03
Wed ..	27	2	25·06	0·397	2	25·08
Thurs.	28	2	34·58	0·375	2	34·60
Fri. ..	29	2	43·58	0·353	2	43·60
Sat. ..	30	2	52·06	0·331	2	52·07

*** *All Communications for this Journal should be addressed to the* Editor, *at the Office,* 35, Northampton Square, Clerkenwell.

TO ADVERTISERS.

As a Special Paper, published monthly and intended to become a work of reference, The Horological Journal will be found to possess advantages to the Chronometer, Watch and Clock-making Community unrivalled for cheapness and efficiency.

N.B. All Advertisements to be inserted in the Journal mst be received before the 25th of the month.

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LECTURES OF THE BRITISH HOROLOGICAL INSTITUTE.

We have great pleasure in announcing, on the part of the Council of the Horological Institute, that they have made arrangements for Three Lectures to be delivered to the members, at the Amwell-street School-Rooms, on Tuesday evenings, May 10th and 24th, and June 7th. The first two will be "On Astronomical Instruments, including the use of the Transit," by Mr. T. W. Burr, F.R.A S., of which a syllabus will be found on the last page. The third will be by Mr. James Ferguson Cole, on some subject in Practical Horology, which will be announced in our next number. These Lectures will not be continued after the above dates *until the next Lecture season*, which commences about the end of October, when the Council hope to announce a complete series on scientific and practical subjects having a bearing upon horology.

They have also to announce, that the Institute has been admitted into union with the Society of Arts, by which means several important advantages will be gained—among the rest, the purchase of books at a greatly reduced rate, and the admission of members of the Institute to the Exhibition of Inventions in the Society's Rooms, Adelphi.

WHAT IS HOROLOGY?

(*Continued from page* 103.)

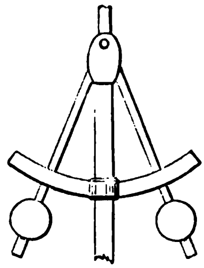
Early History of Clocks—*continued.*

The Conical Pendulum, Repeating and Equation Clocks.

Another ingenious mechanical contrivance, which belongs to the time at which we have now arrived, is the circular or *conical pendulum.* This is attributed, in common with several other inventions, both to Hooke and to Huyghens. It consists of two balls or weights, which are adjustible upon two rods. These rods are jointed at one end to an upright axis, or arbor, having a pinion at its lower extremity which is driven by the last wheel of the train. When the axis revolves, the balls fly out to a certain distance where the centrifugal force is balanced by the force of gravity, and continue to revolve in that plane with great regularity. It will readily be understood, that a shortening of the distance between the balls and the point where they are attached to the axis has the effect of quickening the speed, as in the ordinary clock. See *fig.* 22.

The time of one revolution of such a pendulum in a circle will be equal to that of a double oscillation of a vibrating pendulum whose length is equal to the height of the point of suspension of the revolving pendulum above the plane of the circle in which the ball revolves. For instance, the length of a half-seconds pendulum is nine inches and eight tenths. If the arms of our conical pendulum

Fig. 22.



be made of the same length, it will revolve in one second. The lengths are measured in both cases from the point of suspension to the centre of oscillation. (See page 89.)

By this arrangement we have a smooth continuous motion; and, although not now applied to timekeepers, it has been found very useful in astronomical observatories, for keeping the telescope moving at an equal rate with the star or other heavenly body which may be under observation.

Admiral Smyth, in his "Celestial Cycle," speaks of an equatorial clock with this regulator having been presented to him by the Rev. R. Sheepshanks, and describes it as possessing "a train of wheels which is made to carry a governor, similar to that of a steam engine and its axis, which revolving swiftly occasions the regulating balls to separate, and with the aid of an absorbing wheel gives a smooth action to the hour circle, yet under such control as to be readily adjustible to sidereal, solar, and even lunar motion, so as to make any celestial object appear to be fixed in an immoveable field. This permits such steady gazing, that one of its effects is equiva-

lent to an increase of optical power." The great equatorial telescope at Cambridge is also moved by similar mechanism.

Now that photography is applied by means of the telescope to delineating the heavenly bodies, it becomes increasingly necessary to have the whole apparatus kept in motion at precisely the same rate as the body observed. The slightest relative movement would destroy the distinctness of the resulting picture.

We have recently seen a large telescope, mounted by Cook, of York, in which the clock has a circular pendulum, and which has been used for photographic purposes, with results which are exceedingly distinct and sharp.

The subject of equatorial clocks is one well worthy the further attention of clock-makers, both for the better execution of the new combination of sciences just alluded to, and also for the greater convenience of the ordinary observations of the astronomer.

It will thus be seen that the steam engine governor of Watt was nothing but an adaptation of an horological contrivance. All that he did was to use the circular pendulum with the addition of an arrangement for opening and closing the steam valve by the falling and rising of the revolving balls, as the speed diminished or increased.

The next invention worthy of notice was the mechanism of *repetition*, by which the clock was made, through the pulling of a string, to strike or repeat the last hour. This was the invention of a Mr. Barlow, about the latter end of the reign of Charles II. Barlow subsequently applied this invention to watches, and employed Tompion to make one after his description, intending to patent his invention. Quare, a London watchmaker, had entertained the same notion some years before, but thought no more of it till the noise excited by Mr. Barlow's patent reminded him of his former contrivances. He set to work and finished his watch, and was advised to oppose Barlow's privilege to obtain a patent. The Court was appealed to, and a watch after the invention of each was submitted to the King in Council. His Majesty, after having made trial of both, gave the preference to that of Mr. Quare. The chief difference between them was, that in Barlow's the repetition was effected by pushing in *two* small pins—one for the hours and the other for the quarters, while in Quare's it was effected by one pin only, placed in the pendant of the case.

Nearly about the same period we find *equation clocks* constructed, which exhibited the *difference between* solar and mean time. The *first seems to have been* made in London for Charles II. of Spain, and is thus described by Father Kreser, a Jesuit:—

"From the years 1699 and 1700 there has been in the cabinet of Charles II., king of Spain, a clock with a royal pendulum (beating seconds) made to go with weights, and not with springs, going 400 days without requiring to be once wound up. I have, by order of his Majesty and in his presence, seen and explained the instructions which were sent from London with watches which contained many curious things. I had orders to go every day to the palace during several months to observe the said clock and compare it with the sundial, and at that time I remarked that it showed the equation of time, equal and apparent, exactly according to the tables of Flamstead."*

Sully remarks on this letter, writing in 1717, "What the Rev. Father Kreser relates of the clock of the late King of Spain is very true. It is more than twenty years since such clocks were made in London; and I believe that I am the first who applied this mechanism (for equation) to a pocket watch, 12 or 14 years ago."

As a specimen of the arrangement of one of these old clocks, we give engravings and a description of one known as Enderlin's equation clock, which shows, in addition to both mean and apparent time, a perpetual day of the month, the sun's place in the zodiac, his

Fig. 23.

* At one time Astronomer Royal of England.

rising and setting, and the moon's age and phases.

Fig. 24.

Fig. 23 is the dialwork, and *fig.* 24 the dial itself. In *fig.* 23, the small wheel Q, of 24 teeth, takes its motion from the striking part. It impels the wheel R, of 32 teeth, with a vertical arbor, held in its position by a cock T, on the front plate of the frame, which arbor also has a bend and compound joint (not shown) below T; and a second similar cock above that keeps the lower half of the arbor in its position, the upper and lower pivots also bearing in cocks which are not seen in the engraving. This arbor has an endless screw, S, in the middle of the inclined half, turning a large wheel A, of 487 teeth, and also having a pinion *a*, of 24 leaves, actuating a wheel V, of 32 teeth. This last wheel revolves in 24 hours, *a* in 18 hours, and with it the arbor R T S *a*. Q revolves in $13^h\ 30^m$, and A in 8760 hours, or 365 days 6 hours, whence it is called the annual wheel. The wheel X, with 62 inclined teeth, and the wheel Z, with 90 teeth, revolve separately round one common centre, 5, and are impelled—the former by a tooth or pallet on the 24 hours arbor of the wheel V, and the latter by an endless screw Y. This screw has a pinion, 6, of 21 leaves, upon its upper end, and is impelled by the pinion *a* in $59^d\ 1^h\ 30^m$ being the sum of two lunations. The wheel X is impelled one tooth every 24 hours, therefore an entire revolution would be performed in 62 days; but it does not, in fact, make more than one half of a revolution, when it jumps back to its original situation.

Into the plane of the annual wheel A are inserted 12 pins, at such distances from each other in a circle as correspond to the number of days in each month; the January space being 31 parts out of 365, the February space 28 parts, and so on. On the centre of the annual wheel is also fixed the centre of a piece of metal, B, formed into a curve, which varies its radius of curvature half way round and back again, and is denominated the equation curve. The elements and proportions of this curve are obtained from a table of equations. Round the centre, 5, of the wheels X and Z is moveable the lever 5, 6, with a claw at 6 and a tail 5, 3, resting on a pin in the click 278, which click is moveable round a point at 7. A second lever, 10, has also its tail resting by a pin at 8 on the tail piece of the click, while the end 10 falls in the way of the month pins in the annual wheel, being kept up to them by means of a spring acting near the centre of its motion. The action is as follows:—The pallet at V gathers up a tooth of X every 24 hours, and the click 2 lays hold of it when past and keeps it till next day. This goes on till one of the month pins meeting the end of the lever 10 depresses it; at the same time the tail of this lever pushes, by its pin, the tail 3 of the click back and releases the wheel X. This, having a spring coiled round its centre, jumps back to the place at which it was at first, and the hand D (*fig.* 24) being fast to the wheel, returns with it and recommences its motion from A. The month semicircle is divided into two, and numbered alternately on the inner and outer arcs (we suppose, to avoid crowding of the figures.) At D is an arc divided into 29½ equal parts. The interior part is cut away, showing the moon in full phase as painted on the wheel Z, of 90 teeth. Over the figure of the moon is an index, and both are repeated at the opposite diameter of the wheel, so that one appears at the first division as soon as the other disappears at the end. The face of the annual wheel has engraved upon it the sun's place in the ecliptic, the names of the months, and the time of the sun's rising and setting for each day. These appear through apertures of the dial, shown by the blackened spaces.

When the wheel X has returned to its original position, the pallet at V goes on; and when it has made half a revolution, it touches the end of the lever 6, and discharges the tail 3 from the click 2, which falls back into the teeth of the wheel X, to perform its office until again disengaged at the end of the month. We have seen that the annual wheel

revolves in 365¼ days, therefore the fractional portion of a day will amount to unity every fourth year, and it will then be required that February should have 29 days. This is effected by a piece of brass 15, 16, 17, 18, shown by dots, being hidden behind the annual wheel. This is moveable on the point 15, and has marked on the concealed flat part the four years successively—namely, leap year, and the first, second, and third after, which are brought yearly in succession to an aperture in the dial above VI. in *fig.* 24. This is effected by the star 20 with eight angular points. Two of these points are carried forward by pins in the annual wheel, one on the night of the last day in December and the other on that of the last day in February. The star is kept in its place by the click or leg. A snail of four steps is fastened to the star, and regulates the position of the piece 15, 16, 17, 18, by supporting the end 18; thus the number 1, 2, 3, or leap year, will appear in the dial according as step 1, step 2, step 3, is presented to the projection 18 of the plate having the four years marked on its face. The rack without teeth 11, is moveable on the centre of the annual wheel with a spring (shown by dots) pressing it so as to make it rest on a second snail behind the star. The lever 10 is carried by this rack, and is thus made to meet the pins, or recede from them, a space corresponding to one day, or more if required. The concealed snail having a contrary spiral removes the lever at the last day in February so far from the corresponding pin in the annual wheel that the hand D arrives at the 29th day before it is released, thus giving February 29 days once in four years.

Now for the *equation* movement:—On the point D, in *fig.* 24, the rack E moves its tail *c*, resting on the circumference of the equation curve. At *o* is a box with a spring, which keeps the cord 15 always stretched. This cord surrounds a pulley on the plane of a concealed wheel N, under K, but not attached to it. This wheel acts into the rack which is always resting on the equation curve. The pinion I, of 30 teeth, revolving in 60 minutes and carrying the minute hand, turns the wheel K, of 60, which drives a pinion L, of 30, also in 60 minutes. To L is attached a wheel H, of 48 teeth, which turns a similar wheel F, and this again a third similar wheel G, the tube of which surrounds the arbor of I, and carries the hand with a little sun on it pointing to 30, in *fig.* 24. This hand moves irregularly, and is the equation hand. The irregularity is thus produced:—The wheel N, below K, is pinned to a bar, which is not seen, but which carries the wheel H and pinion L; and as the teeth of the rack are acting in the wheel N, the concealed bar moves alternately towards 1 and 15 as the radius of the equation varies during the year. This motion makes the pinion L sometimes advance and sometimes retrograde a few teeth, independently of the motion it receives from the revolution of K; and this additional motion is also communicated to the wheel H in consequence of its connection with L, and hence to both F and G, the latter bearing the equation hand.

Now as we can easily obtain the amount of equation by simply inspecting a proper table, the elaborate mechanism here described is not of very great value; but the case is different when clocks show *sidereal* as well as *mean* time. It would be a great saving of labour to those who use the transit and the equatorial telescope if a supplementary dial were attached to the clock which should indicate mean time if the clock is regulated to sidereal, or sidereal if it be kept to mean time. This might be effected by a supplementary train of wheels, and we may be able on a future occasion to give a description of such an arrangement.

(*To be continued.*)

A BRIEF SKETCH OF THE HISTORY OF THE

NEUFCHATEL WATCH MANUFACTURE.

By M. Grandjean.

(*Translated from the Revue Chronometrique.*)

Gentlemen,—Upon the invitation of the Secretary of the *Société des Horlogers* to prepare a paper upon the origin of the Neufchatel Watch Manufacture, I have the honour to submit to your consideration a note of its origin, and a brief history of the different phases it has assumed, alluding also to the means to be employed to perfect this art and to maintain the prosperity of the manufacture.

The introduction of watchmaking into the canton of Neufchatel dates back to the year 1665. The first workman who engaged in it was a young man of La Sagne, named Daniel Jean Richard; who, being requested by an English traveller passing through that valley to repair his watch for him, became acquainted with the mechanism, and began to imitate it. To this young man, who afterwards established himself at Locle, belongs the honour of having endowed his country with the rich branch of industry that forms the basis of its present prosperity.

Richard was a goldsmith at La Sagne; he had several brothers, who were engaged with

him in this trade, and he came with them to Locle in the hope of finding better facilities for executing the plan he had formed.

The watch he had put in order was an English frame verge watch with a fusee, and was very high. Instead of a chain, it had a cord of gut; and, in common with other watches made during the infancy of the art, it had no pendulum spring. John Richard met with numberless difficulties. For want of tools and implements, he was obliged to form the teeth of the wheels by hand, as well as the pinions. This induced him to go to Geneva for the purpose of procuring tools and materials that he could not get in the country, and from this time he was enabled to make certain parts with more ease. Independently of the members of his own family, he afterwards took apprentices, and these were the workmen who constituted the first nucleus of the manufacture.

During a long time they contented themselves with making verge watches, adding, among other improvements, the chain and the pendulum spring. Without following all the stages of improvement, suffice it to observe, that the antiquity of a work can always be determined by the different modes of its manufacture. The manufacture of watches has always commenced with the most simple and common kinds.

The manufacture was limited for a period to watches with two plates, to which the horizontal escapement was applied, and subsequently the repeating mechanism, as well as the alarum and chimes. These are the different sorts of fancy watches which have most contributed to develope the taste of the workman, and to make good watchmakers.

The introduction of skeleton watches with horizontal escapements, or Lepine watches, has powerfully contributed to the developement of the manufacture. At this period also several varieties of escapement were introduced, such as the comma, double comma, duplex, and, a little later, the anchor escapement; these sorts being used to vary the construction to the utmost degree. Never, at any time since the origin of the manufacture, were such efforts made for the sake of variety as since the beginning of this century, all intelligent wachmakers having some new ideas to contribute.

Not finding much occupation with the more exact kinds of timekeepers, some of the best watchmakers quitted the country, to go to England and to Paris. Some men who already appreciated this kind of watchwork, and who foresaw that it would one day be the crowning of our industry, were working as amateurs at chronometers, which they delivered in the rough to well-known watchmakers in Paris or London, who finished them, to sell as being of their own manufacture.

The period which dates from 1830 forms essentially a new phase for Neufchatel watchwork, owimg to the improvements in construction and the perfecting of tools. We cannot find that since that period apprentices have been as good as heretofore; far from it, since at first to become a watchmaker, and *to deserve the title*, it was necessary to have worked at all the kinds of watches, and even to have made a watch from beginning to end. To arrive at such a result long apprenticeships with good watchmakers were necessary. I consider this period as a transition period, which divides the history of the manufacture into two parts.

Before this transition period watchmakers applied themselves to construct all the various complicated pieces which were then made. It thus became necessary to make good apprentices, and nobody could pretend to think himself a watchmaker at the end of two or three years practice, as happens in our days.

When the fanciful kinds had had their day, and the construction was simplified, the thoughts of good watchmakers were directed to the perfecting of the escapements by varying the principle, and experimenting with compensation balances. During many years the detent escapement, though it was already known in manufacture, was not used, with rare exceptions for watches of luxury, and not for exact timekeepers. However, the gradual approach to more exact results contributed to produce a good number of watchmakers who devoted themselves to other escapements with compensation balances and spiral or spherical springs.

Some old watchmakers were already engaged in experiments on compensation; and at the Swiss Exhibitions of Industry which preceded the larger ones several obtained gold medals for marine chronometers. The great Exhibitions of London, of New York, and of Paris have shewn out the high character of our manufacture. Unhappily the manufacturers did not sufficiently understand the importance of their being numerously represented at these great tournaments of industry. However, we drew from them this instruction,—that it has been officially proved by the report of the Swiss judges, that we are in a position to compete very advantageously for watchwork of precision, and that we want nothing for arriving at a state of perfection in the manufacture of chronometers but the means of observation. With this we shall be furnished for the future by the establishment of an observatory, constructed at the expense of the government of Neufchatel.

If we are now in a position to manufacture this kind of watches, may we not hope, by the means that we have at our disposal, to see perfected the art of watchmaking in general?

The greater part of the good workmen or artists date from the period anterior to the transition; and it is to be feared, if we do not help the apprentices by practical industrial schools, we shall soon see the decline of the manufacture.

Theory has done much, but industrial schools will do more, when they shall be directed in a way to please, essential to the development of the mechanic.

By the report of the Neufchatel committee concerning the Exhibition of 1855 at Paris, and by the first pamphlet published by the *Société des Horlogers*, it is distinctly proved that it is by complete apprenticeships, and by introducing practical schools, aided by theoretical schools, applied essentially to mechanics, that we can complete what is lacking to the greater number of watchmakers for the manufacture of chronometers, and for the protection of the future of our industry.

Signed by the President,
Locle, Sept. 8, 1858. HENRI GRANDJEAN.

The paper does not end at the point at which we have just stopped; but, as the remainder possesses a purely local interest, we briefly sum it up.

The author further insists upon the incapacity of modern apprentices, and upon the necessity of disseminating professional instruction by means of horological schools, both theoretical and practical. He recalls the usefulness of the school of Geneva, which was created precisely to supply the want of good workmen, become more and more rare—a want which threatened the Geneva manufacture with a speedy decay. "*Progress*," he adds, with much reason, "*will not stop*;" the manufacturers must not go to sleep in their present material prosperity; neither must they forget, as M. Wartmann has likewise said, that one powerful means of maintaining Swiss horology in good condition is to put watchmakers in a position to acquire that special knowledge which practice alone cannot give. We cannot but applaud such judicious counsels, which will find their application as well in France as in Switzerland." [And, may we not add, in England also?—ED. B. H. J.]

CONCLUSION OF "THE PRINCIPLES OF HARRISON'S TIME-KEEPER."

(*Continued from page* 108.)

FIG. 14.

a a a a a a the six pillars of the brass edge.
b b the first wheel.
c the centre-pinion.
d d the second wheel.
e the second pinion.
f f the third wheel.
g the third pinion.
h h the contrate wheel, and the fourth wheel.
i the balance-wheel pinion.
k the fourth pinion.
l l the fifth wheel.
m the fifth pinion.
n n the fly.
o o the balance-wheel.
p the potence.
r r r r r r the six pillars of the frame.
s the stud.
t the centre of the dittent, to stop the balance.
x the centre of the discharging dittent.
u u the upper plate.
z z the pillar-plate.

Let the Diameter of the Upper Plate be 1-16th of an inch more.

FIG. 15.

Is what was designed for the work on the upper plate, which is now done in the manner as represented in Figure 12.

For tempering the Balance-spindle, the Balance-spring, and the Pinions.

Before their being immersed in the metal (as just melted) let them be oiled over.

The heat for the balance-spindle 567 on Fahrenheit's scale, the which is given by one of pewter to 12 of lead; but for the balance-spring and the pinions, let the mixture be one of pewter to 17 of lead.

Each turn of the first wheel (or fusee) is $4\frac{1}{2}$ hours; so $5\frac{1}{3}$ of its turns is just 24 hours; and $6\frac{1}{4}$ is $28\frac{1}{8}$ hours; and $6\frac{8}{12}$ turns equal to 30 hours.

THE NEW METAL ALUMINIUM.

A very interesting paper on aluminium was read at the Society of Arts, on Wednesday, the 2nd ult., by Mr. Foster, the able secretary of that society. First mentioning the extension which chemical knowledge has undergone in modern times, and the boundless supply of aluminous substances which has thus been opened up—in granites, slates, schist, and especially in clays—the author pointed out the fact that aluminium forms an essential portion of our most brilliant gems, including corundum, the sapphire, and the oriental ruby, and emerald; and then proceeded to remark that, notwithstanding the universal diffusion of ores of aluminium, the existence of the metal itself was not known until the last half century, and its extraction has been attended by great difficulty. He then detailed the means adopted for producing sodium by Davy, Gay Lussac, Thénard, Mitscherlich, Brunner, Donny, Mareska, and, more recently, Deville; and traced the labours of Oersted, Wöhler, and Deville, in the production of aluminium. After quoting from the paper read by the Rev. J. Burlow, in 1856, on Deville's process, noticing the modifications which Paul Morin introduced, and sketching the labours of Dr. Percy, Mr. Dick, and Rose (of Berlin), the author stated that—

"Mr. Gerhard, an Englishman, has for some little time past been engaged in experiments with a view to establish the manufacture of aluminium in this country, and to produce it at a cheaper rate than hitherto. He has adopted the cryolite process rather than the double chloride of aluminium and sodium, inasmuch as the cryolite is readily obtainable in large quantities and at a very low price. Mr. Gerhardt has crected furnaces at Battersea, and there is no reason to doubt that with the modifications which he has introduced, added to the fact that the materials are cheaper in this country than in France, aluminium may be produced here at a still lower price than in France, whence the small quantity that has been used in this country has hitherto been imported."

Mr. Gerhard's process he shortly describes as follows:—270 parts by weight of powdered cryolite are mixed with 150 parts of common salt, and into this mixture are placed 72 parts of sodium, cut into small pieces. The whole is then thrown into a heated earthenware crucible, previously lined with a melted mixture of cryolite and salt; which mixture is also immediately poured over the contents of the crucible, covering them to some little depth, over which the lid is then placed. The crucible is then put in a furnace, and kept at a high red heat for about two hours. When the pot is uncovered, the melted mixture is well stirred, and then poured out. The buttons of aluminium are found mingled with the slag, and may be easily melted together by heating them in a crucible with common salt. Theoretically the amount of aluminium produced should be one-third of the weight of the sodium employed, but practically such a result is never obtained, and our manufacturers would be well satisfied with obtaining between a third and a fourth. This Mr. Gerhard has accomplished, though he is not always so successful. There is still some uncertainty in the process. "From what I have seen, and from what I have learnt from those better qualified to judge on matters of chemistry and metallurgical operations than myself, I am led to believe," said Mr. Foster, "that the cryolite process is the one that will ultimately be preferred to that of the chloride of aluminium." As yet, however, the process presents certain difficulties, which Mr. Gerhard appears to have to some extent overcome by his method of performing the operation.

Previous to Deville's labours, aluminium sold at the rate of 3*l.* 15*s.* sterling for an ounce avoirdupois; and when Deville came to England in 1856, the result of his labours had then already caused a reduction in the price to 3*l.* per ounce. Mr. Gerhard also manufactures sodium commercially, and owing, to his labours, the price of sodium has been considerably reduced, being now sold at 16*s.* per pound avoirdupois, while two years ago the price of imported sodium was 6*l.* sterling per pound. Aluminium imported from France fetches 7*s.* 6*d.* per oz.; and there is no doubt that if large quantities of it were required, the supply would be made at once at a considerable reduction on this, which may be termed a retail price. There can be no reason to doubt that at no distant period it will be produced at a cost which will secure its application to numerous important uses. "I may add," says the author, "that, while engaged in the preparation of this paper, I have been informed, and I have no reason to doubt the truth of my information, that certain modifications are likely to be introduced into the manufacture of sodium, so as to enable it to be produced at a marvellously reduced price, which will affect in a proportionate degree the cost of aluminium."

He next noticed the properties of this remarkable metal. One is its extreme lightness, its specific gravity being 2·6, nearly that of glass, whilst that of platinum is 21·5, gold 19·5, silver 10·5, copper 8·96, zinc 7·2, tin 7·3; and, in comparing its price with these metals, this quality must be taken into

consideration. Thus, if one ounce of silver is required to make a spoon, the same weight of aluminium will make very nearly four. The metal is malleable, ductile, almost without limit; it can be reduced to very thin sheets, or drawn into very fine threads. Its tenacity, though superior to that of silver, is less than that of copper: but no very accurate experiments have been made in this respect. When pure it is about as hard as silver. Its elasticity is not great. It files readily, and it is said not to injure the file. It conducts electricity with great facility, so that it may be considered as one of the best conductors known, almost equal in this respect to silver, and more than eight times a better conductor than iron. It melts at a temperature a little above that of zinc, between zinc and silver. In its chemical qualities it would seem to take an intermediate rank between what are termed the noble metals and the common metals, being, as Deville states, one of the most unalterable of metals. It might be imagined that it would as readily re-assume its oxygen as it parted with it with difficulty when in a state of oxide. This, however, is not the case; it appears to be as indifferent to oxygen as either platinum or gold. In air and in oxygen it undergoes no sensible alteration, and it even resists it at the highest temperature which Deville could produce in a cupelling furnace,—a temperature higher than that employed in assaying gold. Water has no action, according to Deville, on aluminium, neither at its ordinary temperature nor when boiling, nor even upon the metal at a low red heat, near its melting point. (According to Professor Crace Calvert, this statement must be received with some degree of caution, as he considers that oxydation takes place slowly when the metal is immersed in water for any considerable length of time.) It is not affected by sulphur or sulphuretted hydrogen, like silver; nor is it acted upon to any considerable degree by any of the oxyacids in the cold; nitric acid, whether strong or weak, at its ordinary temperature, in no way affects it, though when boiling it acts upon it slowly. Small grains of aluminium plunged in sulphuric acid for three months remained apparently unaltered. The vegetable acids, such as acetic, oxalic, and tartaric acids, have scarcely any effect on it at all. The true solvent of the metal is hydrochloric acid, which attacks it rapidly. It appears to resemble tin, when brought into contact with hydrochloric acids and chlorides. Its absolute harmlessness permits of it being employed in a vast number of cases where the use of tin would not be desirable on account of the extreme facility with which that metal is dissolved in the organic acids. But the effect of common agents on the metals in general use has been little studied. Aluminium, like iron, does not unite with mercury, and scarcely at all with lead. It, however, forms a variety of alloys with other metals.

Looking at the various remarkable properties which this metal possesses, it is impossible not to see an immense variety of uses to which it may be applied. Already its lightness and colour has brought it into use for jewellery and ornaments of various kinds—bracelets, combs, pins, seals, pen-holders, tops of inkstands, porte-monnaies, shirt studs, harness, statuettes, candelabra, candlesticks, &c. Its ductility and fusibility render it readily stamped and cast. It works easily under the graver, and being unaffected by the atmosphere, it has an advantage over silver. Its lightness renders it peculiarly fitted for spectacle frames, eye glasses, telescopes, and opera glasses, to which uses it has already been largely applied. It does not stain the skin, as silver does. The alloys too, or aluminium bronzes, as they may be termed, are peculiarly fitted, from the readiness with which they are worked, and their not changing under the action of the atmosphere, *for the wheel-work of clocks and chronometers, as well as the cases too*, for which the metal itself also, from its lightness, is peculiarly fitted. Spoons, forks, drinking vessels, and covers for glass vessels may be made of it, which, even at the present price of the metal, will be much cheaper than silver, while they even possess in a higher degree those qualities for which silver has hitherto been prized. Figuer suggests its use for theodolites, sextants, and surveying instruments, which have to be carried by hand, and where therefore lightness is important. The adjusting screws of such instruments, which when made of silver or brass tarnish from the contact of the hand, might with advantage be made of aluminium.

Professor Blecknode informs me, that the working of this metal has, at his suggestion, been taken up by Mr. Meyer, a jeweller at the Hague, who, amongst other things, has had a bell cast, the handle of which, as a casting, is equal to anything hitherto done in silver. Mr. Meyer's experience shows that the metal works well under the hammer, is well suited for chasing and engraving, as well as for casting. He alludes to the want of a proper solder for uniting several pieces, and has been obliged to adopt riveting, as in Paris. It has already been used by the dentist as a substitute for gold in stopping as well as for fixing artificial teeth, both on account of its cheapness and lightness; but the accounts differ as to its fitness. The special qualities of this metal render it well adapted for coin; and, as soon as it can be obtained

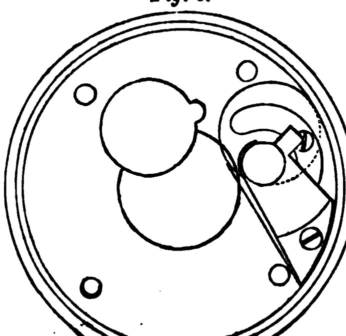
at a sufficiently low rate, it would make an excellent substitute for our copper coinage. Thus, assuming that it can be produced for *5s.* the oz., the price of silver, then looking at its bulk as compared with silver, any coin the size of silver coin would be worth one-fourth of it, and hence an aluminium coin of the size of a fourpenny piece would be worth one penny. Its lightness too, would render any mistake between it and silver impossible. A piece the size of a shilling would be worth threepence. If the price should get still lower, this would not be of any importance, the coins being tokens only, and not passing at their intrinsic value. That the price will be reduced below *5s.* the oz. is a matter which can scarcely be doubted, if we look to the enormous reduction which has been made in a very short time, and when we consider that the manufacture is as yet in its infancy. Let us not despair of its realizing the price of copper, when the Master of the Mint would not look upon it with disfavour. Looking at what has already been accomplished in a few years in the production of this metal, both in quantity and price, from 60*l.* sterling per pound down to 6*l.*, the present price, and seeing that each day brings with it a further simplification of the process and fresh reduction of price, there is every reason to expect that at no very distant period the metal will be produced in large quantities and at very diminished rates of cost, so as to render it available for an infinity of industrial purposes. Unfortunately it appears subject to considerable abrasion under friction. — *Mechanics' Magazine.*

IMPROVEMENT IN THREE-QUARTER PLATE MOVEMENTS,

By Mr. J. B. Watson, *of St. John's Square, Clerkenwell.*

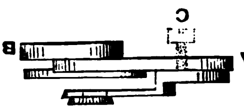
This improvement consists of a convenient arrangement by which the whole of the escapement may be detached and removed from the frame in one piece, complete in itself. It is

Fig. 1.



shown in plan in *fig.* 1, and in elevation in *fig.* 2. It consists of a plate, A, having a

Fig. 2.



large projecting circular boss, B, which is let through the pillar plate. The screw, C, passes in from the back and screws the whole firmly without the use of steady pins. The escape and balance cocks are screwed upon this base plate in the usual manner.

The advantages claimed for this contrivance are, the possibility of manufacturing the escapement complete, independently of the frame, and also of timing and adjusting it by the use of a frame and wheels kept for the purpose. This procedure would save the rest of the work from the handling and disfigurement which it often undergoes in the process of timing.

PROTECTION FROM RUST.

To the Editor of the Horological Journal.

Sir,—The plan proposed in your last number for protecting pendulum springs from rust appears pretty good in theory, but, I fear in practice would be found difficult. It is perfectly true, that a more oxidizable metal when placed in contact with another will protect the latter from corrosion; but this fact depends upon circumstances. It can only protect its neighbour by suffering itself; it becomes rapidly oxidized, and the coating of oxide formed soon covers the whole surface. The effect of this is, to *protect that surface* from further oxidation, and consequently to reduce it to inaction. It will therefore become necessary to remove the oxide as it is formed, or else the metal which it covers can have no preservative power over metals in connection with it.

The instance quoted by "Gnomon," in which the copper sheathing of ships was preserved by contact with another metal, was simply a voltaic arrangement in which the oxide was dissolved as fast as formed. The same thing goes on in a Smee's or Daniel's battery. The oxide of zinc is dissolved by the exciting liquid, and a fresh surface is thus exposed to the action of the latter.

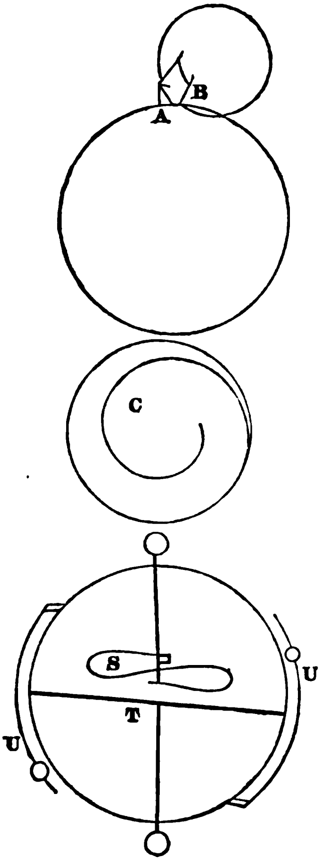
For this reason your correspondent's suggestion is impracticable inasmuch as the zinc stud would require to be kept constantly bright and clear, or else its action would fail. I am, your's obediently,

Polaris.

COMPLETE SPECIFICATIONS OF PATENTS. No. 2.

JOHN ARNOLD.—A.D. 1782.

Complete Specification of Arnold's *Patent for* Escapement and Balance for Pocket Chronometers and Watches.



"The tooth of the balance wheel, A, is an epicycloid, that acts upon the pallet B, which in the part of action is a straight line from the outer edge of the pallet to the centre of the verge. The scape wheel rests on a single pin whilst the balance is vibrating until it is unlocked to add new impulse to the balance. The *incurvating the ends of the helical spring*, C, is attended with the property of rendering all the vibrations of equal duration, because the figure is always similar to itself. The balance is adjusted by two pieces of compound metal which are placed by three or four different ways, as the curved S, the straight piece T, and two circular pieces U, for compensating the effects of heat and cold."

APPLICATION OF ELECTRIC CURRENTS TO ORDINARY CLOCKS,

To the Editor of the Horological Journal.

London, April 8th, 1859.

Sir,—Your readers are much indebted to the Secretary of the Magnetic Telegraph Company, for the information he has communicated in your last number in relation to the application of electric currents to ordinary clocks.

"Polaris," however, is not quite so unacquainted with the subject as he imagines, and *he* thinks that the misunderstanding lies with your correspondent Mr. Bright.

In the account of the method of regulating public clocks by electricity which was published in your sixth number it is stated, that "all the clocks would go as ordinary clocks should the current fail." It was to this statement that I demurred, and do so still, for the reasons which I then adduced.

Had it been objected to my suggestion that induced currents could not obtain in an unclosed circuit, such objection would have some weight; although the fact would still remain of the possibility of an imperfect connection existing, which would subject the pendulum to all the errors which I feared.

As to the interference of terrestrial magnetism, I believe that it has more effect upon pendulums generally, and especially electric pendulums, than either electricians or clockmakers are aware of.

The late Mr. Belville used to say, that at certain seasons of the year—I believe, March and November—all the clocks to which he had access invariably gained on their rates. We have here an indication of a disturbing force which, in the present state of our knowledge, can, I think, only be referred to terrestrial magnetism. It would be interesting to observe whether these periodical fluctuations had any connexion in point of time with the variations of the magnetic needle, and what comparative effect the position of the plane of the pendulum's vibration had upon the rate.

We have had performed, under the direction of the Astronomer Royal, some elaborate pendulum experiments in a coal pit at the Harton Colliery, but these were especially in reference to the density of the earth. A series of careful experiments are yet required upon pendulums whose vibrations shall form various angles with the plane of the meridian.

That a very small extraneous force produces an appreciable effect is proved by Mr. Bright's statement, that a "very heavy clock" is controlled by a single voltaic cell with very

weak solution." This is, no doubt, owing to the place in which the force is applied—namely, to the bob or weight, where the least amount of power will produce the most effect, either in maintaining, retarding, or accelerating the motion. To this is due the failure in uniform timekeeping of those clocks in which electricity is the sole motor, and in which the power is similarly applied;—take Bain's construction as an example.

We have no force more irregular in intensity and quantity than that induced by the current from a voltaic battery. Every variation of this force is impressed thus upon the pendulum, and the consequence is a fluctuating rate of performance.

I have no question, however, that the controlling system as applied to public clocks is a great improvement upon the present very imperfect and very unscientific state of public timekeepers; and I should be happy to see it introduced in London, not merely in the neighbourhood of Cornhill, where similar facilities already exist, but in districts less favoured and more needing the boon.

I am, your's obediently, POLARIS.

DUPLEX AND DETACHED ESCAPEMENTS.

To the Editor of the HOROLOGICAL JOURNAL.

Clerkenwell, March 29th, 1859.

Sir,—In the papers in defence of English Watchwork now being published in your journal, the treatment of the subject of the *duplex escapement* does but scant justice to that very excellent construction. Some faults are attributed to it which are not peculiar, and the case is sought to be strengthened by comparison with the *detached* escapement.

In the first place, the detached escapement is stated to be more simple. Now, if simplicity consists in a smaller number of parts, this is certainly not the case, inasmuch as the detached escapement has a detent.

It is said, that "the whole angle of escapement for the teeth has to be performed by the balance before the impulse action can be started." But in the detached escapement a similar angle has to be described to release the detent, during which the motion of the balance is retarded by a spring essentially variable in its properties. The result is, that a detached escapement stops in the pocket *more often* than the duplex.

The diagram of the levers in a Stanhope press given in your correspondent's communication does not apply, simply because it is not a case of jointed levers, but of toothed wheels. The side of the roller notch answers to the tooth of a small pinion, and the thrust is not directly outwards, but nearly at a tangent to the circumference of both.

But the duplex escapement is inferior to the detached for a reason which your correspondent does not give;—it is not a *perfectly detached* escapement. The long tooth lies against the roller, and thus produces a slight retardation from friction.

As to delicacy, however, I must entirely differ from those who would prefer the detached escapement on such a ground. My experience is entirely in favour of the duplex as a pocket watch, distinguished for accuracy and durability. I have never had any difficulty in making it myself, or in getting it made, with sufficient precision to avoid all fault of stopping; and I have always found evident reasons for such a fault in a duplex escapement when it has shewn itself.

There can be no question that the detached escapement bears away the palm as the best for marine chronometers; but for the pocket watch, where sudden motion must be provided against, I believe the duplex is the least likely to fail.

I am, your's, &c.

DUPLEX.

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

Printed by order of the Commissioners of Patents, and published at the Great Seal Patent Office, 25, Southampton-buildings.

(*Continued from page* 113.)

1788, February 1.—No. 1354.

WRIGHT, THOMAS.—This invention relates, first, to the application of horizontal bars, the upper side of which is of steel or iron, and the lower side of copper, zinc, and silver or brass compounded with other metals, so as to have the property of expanding more than the upper side; which bars are used either alone, or in conjunction with other bars, in which the more expansive metals are uppermost, for the purpose of causing the pendulum ball to be raised in proportion as the pendulum spring is lengthened by expansion (or vice versâ), the pendulum being fastened to the bar or bars in various ways.

2. The application of the same metals to the rims of the balance; the rims being divided in certain places, and being heaviest nearest to such divisions, so that, as the outside of the balance are the most expansive, the free extremities of the rim are forced nearer the centre of the balance, and thus counteract the effect of the expansion.

3. A pendulum escapement. The hook of the detent lever acts on pins placed on the balance wheel, and the hook is discharged by a pallet falling on it; which pallet is fixed to an arm attached to the verge staff, and then motion is given to the pendulum, by the tooth of the escape wheel falling on the pallet which it does immediately after it is disengaged from the detent lever.

4. A scapement where the locking spring is bent up by a pin on the verge, and the tooth of the escape wheel released. On the return of the balance this pin presses on the contrary side of the spring, and the wheel continues locked.

[Printed, 6*d*. See Rolls Chapel Reports, 6th Report p. 167]

1783, June 17.—No 1377.

FISCHER, John.—A geometrical and pedometrical watch. The machinery may be introduced into any watch, except a repeater, and is wholly unconnected with the works. The dial has, besides the usual one three specific circles of figures. The outside one has 100 divisions, the second has 10, and the third has 20. The first makes every step up to 100, the second every 100 up to 1,000, and the third every 1,000 up to 20,000. The machinery works by means of a pusher through the pendant, like a repeater, the pusher being connected to the dress by a string, which is kept at a proper stretch, by a little instrument, containing a common barrel with a watch spring inside. The motion of the leg in walking operates on the pusher, so as to turn a snail of 10 teeth one tooth every step, the pinion of which pitches into the centre wheel of 100 teeth, which, by means of the great hand, marks every step on the large circle. When the great hand has gone round once, it moves another snail of 10 teeth one tooth, which is shown by the hand of the second circle; and when this hand has gone round once, it moves a snail of 20 teeth one tooth, which is shewn by the hand of the third circle. When this last hand has completed its round, 20,000 steps will have been marked.

By additional wheels, 100,000 steps may be marked on the outside circle; a small circle shewing every step up to 10, another every 10 up to 100, a third every 100 up to 1,000, while the outside circle marks every 1,000 up to 100,000. Indeed, by the aid of wheels and levers numberless alterations in the number may be made.

It is of importance that the watch fits close in the pocket.

[Printed, 6*d*.]

1785, August 5.—No. 1495.

CHATER, James.—Watch and note guard. The guard is fastened to the watch by a shank, and the mechanism is as follows. A tongue is made to act on a joint, near the lower part of the guard, nearest the watch. By pressing a small stud at one side of the guard, the upper end of the tongue flies out, in consequence of a bolt, by which the tongue had been held down, being withdrawn, and the tongue being then acted upon by a spiral spring inside the guard. The tongue remains standing out to an acute angle until the stud is placed in its former position. Across the inside of the pocket is sewn a spring behind which the tongue, if the watch is attempted to be withdrawn, slides, and the watch is thus held fast. The invention may be applied to the hook which connects a lady's watch to the chain, or to a note case, which should be made curved to fit the thigh.

[Printed, 1*s*. 1*d*.]

1788, May 20.—No. 1650.

WHITE, James.—The part of this invention which relates to clocks is the following. In common striking clocks the descent of the weight is checked by a train of wheels and an air fly, instead of which the patentee uses a vibrating body; that is to say, he regulates the strokes on the bell by means of a pendulum or balance, of any shape, which he causes to vibrate in various ways. He attaches the hammer which strikes the bell to the vibrating body, on its centre of motion. The number of strokes he regulates in various ways, not confining himself to any in particular.

[Printed, 11*d*. See Rolls Chapel Reports, 6th Report, p. 179.]

1789, November 6.—No. 1708.

HARLOW, Samuel Boulton.—The application of a friction joint over the spout of a watch key, so as to prevent damage when the key be turned the wrong way. Immediately below the friction joint is fixed a flat horizontal plate, to the under part of which one end of a curved spring is fastened, and at the other end of which is a click or catch which rises through the upper surface of the plate. The click is sloped or bevilled at one side, so as to form no obstacle when the fly is turned the wrong way, and is square or upright on the other side, so that, when the key is turned the right way, the resistance of this side gives motion to the spout.

[Printed, 3*d*. See Rolls Chapel Reports, 6th Report, p. 180.]

1791, August 13.—No. 1823.

MACKENZIE, Colin.—A new link for a chain. At each end of a piece of metal (or other substance, such as hemp or leather) is made an eye or hole. The metal is then bent into an oval, or other shape, to form a link. To unite the links to form a chain, pass each one through the eyes of the preceding one.

[Printed, 3*d*. See Rolls Chapel Reports, 6th Report, p. 184.]

1794, October 14.—No. 1830.

LITHERLAND, Peter.—An escapement. The rack acts on the pinion on which the balance is rivetted. The pallets on which the pallet wheel acts, may be across, or at the side of the lever. The lever "gives power to the balance to react upon the wheel-work, by which the balance acts from its own nature." The rack may be also applied for the purpose of winding up watches or clocks without a key.

[Printed, 6*d*.]

(To be continued.)

British Horological Institute.

MEETINGS FOR MAY.

Tuesday, May 10.—LECTURE, at 8½ P.M., at the Amwell-street School-rooms,

On Astronomical Instruments and their Uses,

By Mr. T. W. Burr, F.R.A.S. &c.

Syllabus.—Sketch of Sidereal Astronomy.—Identification of the Stars.—Instruments for determining their places.—Right Ascension determined by the Transit instrument.—Its Invention.—Description.—Mode of adjusting and using.—The Transit Clock.—Time, Sidereal and Solar.—Mean and Apparent Solar Time.—Causes of the Irregularity of the Sun's Apparent Motion.—Equation Table.—Value of the Transit as a check upon Timekeepers.—Declination ascertained by the Mural Circle—Description and Use of that Instrument.—The Time Ball.

Tuesday, May 17.—Special Meeting of Members, at 8 P.M., at the Offices, Northampton-square.

Tuesday, May 24.—LECTURE, at 8½ P.M., at the Amwell-street School-rooms.

On Astronomical Instruments and their Uses,

By Mr. T. W. Burr, F.R.A.S. &c.

Second Lecture.

Syllabus.—The Telescope.—History of the Invention.—Two kinds of Telescopes, Refractors and Reflectors.—Two forms of Refracting Telescopes.—Illustrations of the Optical Principles of their Construction.—Discoveries made by the early Telescopes.—Their Defects.—Spherical Aberration—Chromatic Aberration.—Invention of the Reflecting Telescope by Newton.—Discovery of Achromatism by Dollond.—The present form of the Achromatic Refractor.—Construction of large Reflectors by Sir W. Herschel.—The large Telescopes of Lord Rosse, and their results.

Declinations of the following Stars, and Times at which they are on the Meridian at Greenwich, for May, 1859.

Name of Star.	Day of Mon.	Dec. North °	′	″	Greenwich Mean Time of passing the Meridian. h.	m.	s.	
β Leonis	1	15	21	24·9	9	4	52·39	P.M
	11	15	21	25·9	8	25	33·21	„
	21	15	21	26·8	7	46	14·00	„
α Bootis (*Arcturus*)	1	19	54	47·9	11	31	50·52	P.M
	11	19	54	49·4	10	52	31·45	„
	21	19	54	51·0	10	13	12·34	„
α Ophiuchi	2	12	39	39·2	2	50	17·01	A.M
	12	12	39	40·8	2	11	7·27	„
	22	12	39	42·6	1	31	49·29	„
		Dec. South						
α Virginis (*Spica*)	1	10	25	46·5	11	40	21·18	P.M
	11	10	25	46·6	10	1	11·92	„
	21	10	25	46·5	9	21	52·79	„

EQUATION OF TIME TABLE
For May, 1859.

Day of the Week	Day of Mnth	At Apparent Noon — Equation of Time to be *subtracted* from Apparent Time. m.	s.	Difference for One Hour. s.	At Mean Noon. — Equation of Time to be *added* to Mean Time. m.	s.
Sun. ..	1	3	0·00	0·308	3	0·01
Mon. ..	2	3	7·39	0·286	3	7·40
Tues ..	3	3	14·24	0·263	3	14·25
Wed. ..	4	3	20·54	0·240	3	20·55
Thurs.	5	3	26·28	0·217	3	26·29
Fri. ..	6	3	31·48	0·194	3	31·49
Sat. ..	7	3	36·13	0·171	3	36·14
Sun. ..	8	3	40·23	0·148	3	40·24
Mon. ..	9	3	43·78	0·125	3	43·79
Tues ..	10	3	46·77	0·101	3	46·78
Wed ..	11	3	49·22	0·078	3	49,22
Thurs	12	3	51·10	0·055	3	51·10
Fri. ..	13	3	52·41	0·032	3	52·41
Sat. ..	14	3	53·17	0·008	3	53·17
Sun. ..	15	3	53·37	0·015	3	53·37
Mon. ..	16	3	53·00	0·039	3	53·00
Tues ..	17	3	52·07	0·062	3	52·07
Wed ..	18	3	50·58	0·086	3	50·57
Thurs.	19	3	48·52	0·109	3	48·51
Fri. ..	20	3	45·90	0·132	3	45·89
Sat. ..	21	3	42·72	0·155	3	42·71
Sun. ..	22	3	38·99	0 178	3	38·98
Mon. ..	23	3	34·70	0·201	3	34·69
Tues ..	24	3	29·87	0·223	3	29·86
Wed ..	25	3	24·52	0·245	3	24·51
Thurs.	26	3	18·63	0·267	3	18·62
Fri. ..	27	3	12·24	0·288	3	12·22
Sat. ..	28	3	5·34	0·307	3	5·32
Sun. ..	29	2	57·97	0·326	2	57·95
Mon. ..	30	2	50·14	0·345	2	50·12
Tues ..	31	2	41·85	0·363	2	41·83

TO CORRESPONDENTS.

E. Storer.—We propose to insert some further information with respect to "Ferguson's Mechanical Paradox"—in our next Number, if possible,—with an Engraving of his method of applying it to the construction of a small orrery. Your reasoning is true so far as it goes; but we quite agree with you, that nothing unforeseen or paradoxical would take place in the arrangement which you suppose to be that of Ferguson's. It must be a *mental* delusion, not an *optical* one, that could see retrogression in such a case. Motion is always relative.

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THE BRITISH HOROLOGICAL INSTITUTE.

In accordance with the announcement in our last number, two Lectures have been delivered to the members of the British Horological Institute. The subject was "Astronomical Instruments in relation to Horology;" and the experiment has proved successful. A copious abstract of both Lectures will be found in the present number. The Third Lecture will be given on the 7th of June, on a very practical subject, by a practical man. The syllabus will be found on the last page.

A Special Meeting of the Members of the Institute was held, at the Offices, 35, Northampton-square, on Tuesday evening, the 17th of May, pursuant to notice. The object was to discuss and adopt a revised code of laws, of which a copy had been forwarded to each member, and to elect auditors for the current year.

Mr. W. Hislop having been called to the chair, and having stated the object of the meeting and the course proposed to be pursued, proceeded to read the revised laws, and to take the sense of the meeting upon each clause.

After a few alterations the whole were passed; and it was moved by Mr. Stoddart, seconded by Mr. Fletcher, and resolved unanimously, that the laws as so revised should be adopted as the Rules of the Institute in the place of those hitherto existing, and that they should take effect from a period fourteen days previous to the next annual meeting in June.

Messrs. J. F. Cole, David Taylor, and Jas. Stoddart were appointed auditors; and a vote of thanks having been tendered to the Chairman, the meeting separated.

We have also to call the attention of members to the Collection of Models, &c. at the offices of the Institute. Articles have been contributed on loan, and donations made to the Institute, by Messrs Grimshaw, Johnson, Watson, Hislop, Breese (jun.) Kullberg, Stoddart, Whittaker, Robarts, and Cole.

WHAT IS HOROLOGY?

(*Continued from page* 118.)

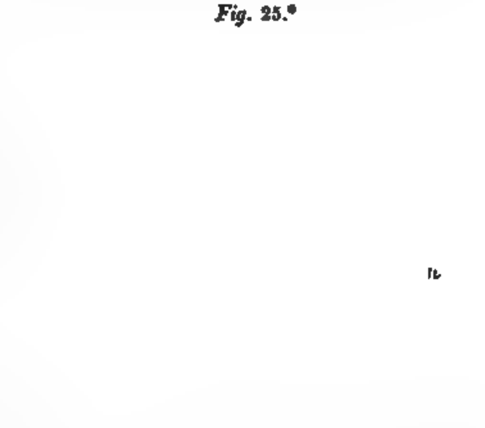
Early History of Clocks—*continued.*

Improvements in Escapements.

The introduction of the pendulum as a time measurer in connection with clocks rendered it necessary to employ some new escapement which would allow of a smaller arc of vibration. The crown wheel escapement, as we have seen, was the first that was employed; but, from the fact that it required a large angular motion, it was found to be defective. We have already shown that the curve described by a pendulum bob approaches the nearer to that requisite for isochronism as it becomes shorter, consequently a pendulum whose arcs of vibration are small will keep a more uniform rate under varying lengths of oscillation than one whose arc is greater. Huyghens endeavoured to adapt the verge escapement for the purpose by placing the pallets at an angle of 60° instead of 90°, as made for a watch; but this did not prove sufficient to obviate the defect.

In the year 1600 Dr. Hooke is said to have exhibited before the Royal Society of London an anchor escapement, while some assert that it was invented by Clement, a London clockmaker. This anchor or *recoiling* escapement

Fig. 25.*



is shewn in *fig.* 25 in its best form. On the arbor A are fixed the pallets E A F, shewn in the position taken when the tooth is just about

* The Engraver has not given sufficient "drop" in this woodcut.

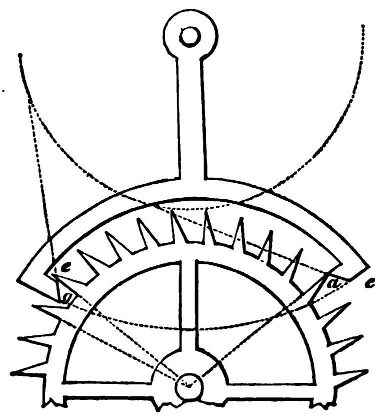
to escape. B b, C c are the faces of the pallets upon which the teeth of the wheel act. These are made at such an angle that the teeth push them out on each side; thus, B pushes the pallet to the left, and C pushes *its* pallet to the right. Now, suppose the pendulum drawn aside to the right, and let go. The tooth B, pressing on the face of the pallet from m to b, thrusts it aside outwards, and thus, by the connection of the pallets with the pendulum rod, aids the pendulum's motion along an arc parallel to Q P R. When the pendulum reaches R, the point of the tooth B has reached the angle b of the pallet, and escapes from it. The wheel turning forward, another tooth, C, drops on the pallet face C c, and by pressing this pallet outward evidently aids the pendulum in its motion back from R to P. The tooth C escapes from this pallet at the angle C c, and now a tooth, B, drops on the first pallet, and the operation is repeated. Each tooth of the wheel acts on each pallet in succession, and for the escape of each the pendulum makes one vibration. The number of vibrations, therefore, during one turn of the wheel is double the number of teeth; consequently, while the tooth slides along one of the pallets, it advances half the space between two teeth, and when it escapes the other tooth is just in contact with the opposite pallet. Should this second tooth chance to touch the pallet before the first has escaped, the wheel will advance no further, and the motion of the pendulum will be gradually stopped. One tooth must therefore escape a little before the other reaches the pallet, and there must be a small drop of the teeth from pallet to pallet.

The pendulum swings somewhat beyond the angle of escapement; for if it went no further than the drop of the tooth when clean and in good order, it would cease to escape when the vibration diminishes through thickening of the oil. This circumstance of exceeding the angle of escapement produces the effect known as *recoil*, and gives a designation to this particular form. By referring to the diagram it will be seen, that if the pendulum continue its motion from left to right after the tooth B has dropped upon the pallet m b, the pallet will push the wheel back again while the tooth slides outwards on the pallet m; consequently a motion of recoil is produced.

A series of experiments were made by Berthoud on a clock with a half-seconds pendulum weighing five drachms, and having a recoiling escapement whose pallets were planes. The angle of escapement was $5\frac{1}{2}$ degrees. When actuated with a weight of two pounds it swung 8° and lost 15″ per hour, with four pounds it swung 10° and lost 6″. *Thus, by doubling* the maintaining power, *although the vibration was increased*, the time was accelerated 9″ per hour or about $\frac{1}{400}$. Now, although the variation in the maintaining power would never be to so great an extent under ordinary circumstances, yet the variation produced by friction, arising from various causes, would be sufficient to destroy the accuracy of a clock constructed with such an escapement. In some varieties of the recoiling escapement the planes of the pallets are curved, as is also the side of the tooth impinging upon them. This form diminishes the tendency to cut or pitt the pallets.

George Graham, about the end of the 17th century, contrived the horizontal escapement for watches, and then applied the same principle to clocks, so as to give a smaller angular motion. Both these escapements give a *dead beat*, and the clock escapement is therefore known by that name. It differs from the recoiling escapement by taking off a part of the slope of each pallet and making that portion form a portion of a circle described from their centre of motion. On this concentric plane the tooth of the wheel falls, and remains while the pendulum moves through that portion of its vibration which exceeds the angle of escapement. *Fig.* 26 shows this escape-

Fig. 26.



ment. $e\,e'$ are the planes of rest, forming arcs of circles, whose centres are the centres of motion of the pallets; $a\,g$ are the planes of impulse. The tooth, as it escapes from a, falls on the plane of rest e, and continues there until the return of the vibration brings it on to the plane of impulse g, along which it passes until it escapes, when another tooth will fall on e', and the action will be continued. It will be seen that the pendulum gets its impulse in the very middle of its vibration, when the velocity is the greatest, and the pendulum has therefore the greatest governing power, and thus a variation in the moving force will have the least effect. Thomas Grignon presented a clock to the Society of Arts in 1759, which still remains

in their rooms, having a dead-beat escapement of this kind. This clock is said to have kept the same rate with a weight of *four pounds* and with one of *twelve pounds* suspended as a maintaining power. However this may be, it is certain that no escapement has done better service; and, even at the present time, it is still a question whether any other construction can excel it for accuracy and durability.

About 10 or 15 years after its introduction by Graham it became known in France, where it was adopted as the best for clocks intended to measure time accurately. Lepaute, a Parisian watchmaker, produced, about the year 1753, a modification of this particular form of rather a remarkable character. The teeth of the escape wheel were replaced by sixty steel pins, thirty being arranged on each side of the wheel. This form has been revived of late for turret clocks; but it is difficult to keep the oil to the point of action.

This escapement is shown in *fig.* 27. On an

Fig. 27.

arbor, F, are fixed two pallet arms of the shape shown. The arm G A *e* is behind the swing wheel, the other, H B *d*, is on the opposite side; and the acting parts are at such a distance from each other as just to allow a proper freedom for the plane of the wheel to pass between them. One of the arms is riveted to the socket; the other turns with difficulty, so as to allow it to be set at any angle required. The parts R I, L S of the pallets are arcs of a circle whose centre is at F; the impelling planes are I *e*, L *d*. The pins have one half of their diameter removed to allow of closer drop.

The wheel turning in the direction of the arrow, the teeth on the upper side meet the plane L *d*, and push it towards B; the pallet G A *e* on the opposite side of the wheel also advances under the next advancing pin; at this moment the pin V, having escaped from the point *d*, the pin on the opposite side falls upon the plane or arc of rest R. The pallet arms being brought back by the descending oscillation, the pin slides down the inclined plane, falls from it, and another pin on the upper side drops on to the arc of rest S L.

These escapements were a great advance in horology, and reduced the errors hitherto apparent so completely as to make apparent a new source of error in the pendulum, of which we shall treat in our next paper.

(To be continued.)

UNIVERSAL OR TRAVELLERS' WATCHES.

(Extract from Report presented to the Société des Horlogers of Paris.)

Of late years a great number of experiments have been tried by different intelligent artists, to make watches which could give two different hours, independent one of the other, and destined principally for the use of travellers by railway. That of M. Anquetin presents a novel idea, which appears to us to unite the advantages, which we are about to have the honour to point out to you.

Instead of seeking for the solution of the question in double dials and minute hands turned by the wheels, the author makes his dial in three parts, of which the one which is fixed forms the ordinary dial, and the two others form together another dial, moveable and concentric to the first.

A large *minuterie*, independent of the ordinary one of the watch, is placed in the thickness of the principal dial, and is then solidly held by a wide and thin steel key.

The minute wheel has a circular raised rim, which comes on a level with the principal dial; the hour wheel has a disc which just fills up the space left empty by the circle above mentioned. On this circle are marked

the minutes, and on the disc are marked the hours.

The same hands therefore indicate, at the same time, the hour on the ordinary dial and on the moveable one.

A button placed on the pendant of the watch guides a pinion. It acts on a wheel which puts in movement, in whatever way may be desired, the zone marking the minutes, and the small central disc which marks the hours.

For the facility of travellers, the inventor has inscribed on the ordinary dial the names of the principal cities of Europe, according to the angle which each of their meridians form with that of Paris.

This dial therefore indicates the longitude desired, by making, between the indication of the ordinary dial and that of the moveable one, an angle equal to the longitude which it is wished to obtain.

This skilful arrangement leaves full liberty to the works, and allows this dial to be readily applied to ordinary watches already made.

In addition to the principal application which the inventor has had in view, it is useful to point out, as one of the important advantages of this watch, that it gives immediately and without any previous calculation, the account of the time which has elapsed between two periods, and it may be also usefully employed when there is a difference of time to be calculated.

M. Anquetin makes, also, an analogous system of clocks and watches with one hand of longitude giving the hour of every place comparatively with that of any other, as far as it can be.

FUSEE *versus* GOING BARREL.

To the Editor of the HOROLOGICAL JOURNAL.

Sir,—I had hoped that some more able correspondent than myself would have taken up the question "Fusee *v.* Going-Barrel" at the point at which it was left by your correspondent "Cornhill." As, however, a further silence might in some minds prove consent to the line of argument last taken, I will venture to express my opinions on the subject.

I apprehend the question simply is, which is the best for uniformity of time-keeping, and also for soundness and facility of construction.

It will not be a fair test if we take as our standard time-keepers constructed in some peculiar manner or of such a size as will shut off the peculiar properties of either the going-barrel or the fusee. It may be very true, that certain persons will have flat watches; but it is also equally true, that flatness and minuteness of size are so inimical to exact performance that no one in his senses would ever expect it of such machines. The rage for minute watches is now apparently on the wane, and is only ministered to by dealers who find their interest in it.

For these reasons I think the experiments given by "Cornhill" are of little value. I will even admit that in watches of the ordinary selling size of Swiss manufacture it may be better to get rid of the fusee and chain, as being more delicate than the going-barrel; still we must bear in mind that the breaking of a few mainsprings will distort and bend the barrel out of truth and consequently out of depth into the centre pinion. This is often a source of error in watches of this kind which have been made a few years.

The line of argument taken by M. Henri Robert, in the extract given by your correspondent, is, however, more to the purpose, relating as it does to Nautical Chronometers. M. Robert gives two diagrams to explain his notion of the action of the spring (see page 95), in which he asserts that the power is always employed at a tangent to the outer coil of the spring. He thus assumes that the exterior coil is to be regarded as a cylinder diminishing in size as the spring is wound up and therefore exerting less power. But the spring forms its own connexion with the barrel, and therefore the line joining the outer part of the cylinder formed by the spring and the inside of the barrel is itself elastic, and thus exerts an appreciable effect on the result.

The fact is, that the power is exerted in a direction of which the resultant is a line drawn from the point of intersection of the barrel and pinion teeth to another point which depends upon the elasticity of the spring, varying from the inner surface of the barrel to a position between it and the outer coil of spring when wound to the top.

This will, it is true, give a slight compensation of leverage, but so small as to be practically of no value. A simple experiment will prove more than reams of argument. Let any one possessing a main-spring adjusting tool affix it to the arbor of a going-barrel, and note carefully the position of the weights necessary to just overcome the resistance for each turn of the spring from top to bottom. If this does not show any one that equal adjustment of a main-spring in a going-barrel is impossible, I know not what will.

But there is another point deserving our consideration in connection with this subject. It may be said that the peculiar properties of an elastic spring, when applied to the balance spring, will counteract and compensate the

varying of the maintaining power, that is to say, that as a spring exerts more force as it is wound further, so the increased power transmitted to the balance will cause a larger amount of vibration, producing a greater bending of the pendulum spring and a consequent increase of *its* power and a quickening of the vibrations. Now this is all very true so far as it goes, but we must remember that we introduce fresh elements of error in the case we contemplate. The laws governing a balance and spring vibrating freely are considerably modified when applied to one which is vibrating in connection with a train of wheels. By an increase of force an increase of friction is caused in the link which joins the train and balance, namely, in the escapement, which produces varying results in different escapements.

But the isochronism of a spiral or cylindrical balance spring has, I fear, only been dealt with hitherto in an empirical manner. No definite laws as to curves or power are yet laid down, and it remains for some one qualified by experience and attainments to enter upon a course of experiments which will give reputation to his name, and confer a lasting benefit upon horology.

I am, Sir, your's obediently,

FUSEE.

ABANDONMENT OF THE PROPOSED EXHIBITION OF 1861.—It was announced a short time since that arrangements were in progress for holding a Great Exhibition of the Fine and Industrial Arts in 1861. The opinion of many of the principal manufacturers of the metropolis and of the country was taken on the propriety of holding the proposed Exhibition. The feeling among those who were the principal exhibitors in 1851 was generally against the proposal, or, in cases where not opposed to the scheme, a very large amount of apathy was manifested on the subject. The reminiscences of the display of 1851 were by no means agreeable to many who were then exhibitors, and they evinced a very natural dread of embarking in an undertaking of a similar character. There were, however, several eminent firms who stated that if the exhibition were to be held they would consent to contribute specimens of their manufacture, though upon the whole they would rather that they were not called upon to do so. The result of the appeal has been, we believe, that about 300 manufacturers in London and in the country consented to become exhibitors. Added to this want of active sympathy with other objects of the promoters of the undertaking, on the part of English producers, there is now the difficulty interposed by the state of affairs on the Continent, and it would be idle to suppose that the European nations would entertain with much favour a proposal just now to become competitors in the peaceful arena of art and industry while their attention is engrossed with the more momentous struggle of military powers. Under these circumstances it has been decided that no further steps be taken towards carrying out the proposed Exhibition of 1861.—*Observer.*

A METHOD OF REMOVING STAINS FROM METAL SURFACES.

One of the properties of cyanide of Potassium is, that it dissolves most metallic compounds with great ease. Hence it is extensively used in Photography for removing the iodide of silver from the sensitive surface, and thus fixing the picture. It is also used in Electro-metallurgy for holding in solution the oxides of the metals which are required to be deposited by the electric current. This property renders it available for removing stains or tarnish from the surface of silver, brass, or gold, inasmuch as it will attack and dissolve the extraneous compound and leave the metallic surface perfectly clean. All that is required is to make a saturated solution of Cyanide of Potassium, and either dip the article to be cleansed therein, or touch the stained parts with a soft brush dipped in the solution. The article must then be washed in clean water, and carefully dried.

ELECTION OF OFFICERS AT THE ENSUING ANNUAL MEETING.

To the Editor of the HOROLOGICAL JOURNAL.

Sir,—Will you permit me, as a member of the Horological Institute, to call the attention of members to the importance of attending and voting at the coming Annual Meeting. It is perfectly certain that the success of all these societies much depends upon the energy and ability of the elected officers. We shall have, at the ensuing meeting, to elect a new Council as well as a President and Vice-Presidents. Let us take care to have men of knowledge, whether they be employers or employed. Do not let us vote for names merely because they may happen to drive a large business or possess large shops, but let us choose those whose scientific attainments qualify them for taking the lead in so pre-eminently scientific an object as that which is aimed at by the British Horological Institute. I am, Sir, your's obediently,

A FELLOW MEMBER.

DESCRIPTION OF A PORTABLE ASTRONOMICAL CLOCK CONSTRUCTED AND MADE BY J. F. COLE.

The two Engravings on this and the opposite page represent a Front and Back View of the Clock, on a scale of proportion equal to half the dimensions of the original, which is contained in a silver case about six inches in height.

The general design or calibre of the movement of this Clock is an arrangement so disposed as to admit the largest amount of power in the smallest space, as shewn by the unusually large diameter of the great wheels and double acting barrel which drives the two trains of the going and striking parts, giving hours and quarters regularly on bell springs, by mechanism resembling in some particulars clocks of the justly celebrated M. Breguet.

This Clock also repeats the hours and quarters, at pleasure, by touching a projectile stop at the top of the case.

The dial plate, also of silver, is quite an original design as regards arrangement of the various indications on the several circles, and scales of figures on segments drawn from three excentric points surrounding the true centre of the hour circle.

Hours, minutes, and seconds are shewn by the principal steel hands, and the time is governed by a compensation balance and spring, as usual; the escapement being a detached lever, with a flat steel wheel having the impulse angles formed wholly on the wheel teeth, in the manner of Graham's horizontal wheel, without columns; the pallets acted on by the planes of the teeth being two arms of equal length, with ruby pallets set to represent the edges of a ruby cylinder scaping over three teeth. The wheel in this is a tempered one, and has performed well for 30 years, without the slightest injury from action.

On the dial plate, the small circle at the right shews the days of the week; the corresponding circle at the left shews the months; and the segment below shews the days of the month, by a gold indicator band, which is governed by the mechanism seen at the right of the back view given in the engraving. This particular mode of shewing the perpetual day of the month is an original improvement, constructed to correct the unequal months of 30 and 31 days, for the 28th day of February, and the 29th day in leap year. Below the centre is a semicircular indication of the Moon's age and phases; and above the centre is a similar aperture, enclosed by the second's circle. Within the circle is a blued steel plate, *carrying* a disc of silver representing the apparent motion of the Sun. This small disc *appear above and disappear* below the moveable horizon daily, through all seasons of

the year; the smaller segments at the left and right with gold indicator hands, shew the time of sun rising and setting.

Outside the circular rim of the dial are two apertures—one where the key is inserted for winding the clock, and the other for setting the hands as marked on the gold tablets. The key applied at this one point commands all the motions, which are always correct, unless the clock is allowed to go down. On the side of the silver case is a sliding stop, which may be set to strike hours and quarters, or quarters only with the hour at the proper time; and if the stop is set to the lowest point, at the mark "Silent," the power of the striking part is transferred to the going part, and by this the period of going will be prolonged to nearly a month.

[Seven similar clocks, and pocket watches containing the above and other properties, were constructed and made by Mr. Cole, about 30 years since, at prices varying from 100 to 300 guineas each.—Ed. H. J.]

SUBSTANCE OF THE LECTURES

DELIVERED BEFORE THE

British Horological Institute.

First Lecture.

ON ASTRONOMICAL INSTRUMENTS.

By Mr. T. W. Burr, F.R.A.S.

The Lecturer commenced by observing that a knowledge of the use of astronomical instruments involved an acquaintance with Elementary Astronomy. The especial object of the present Lectures before the Horological Institute being to consider the subject in reference to time, it would be well to consider the use of instruments as time-keepers, and also to notice time-keepers in connection with instruments. The subject was so extensive as to render it impossible to do more than make a beginning in these lectures.

The division of the subject would be, first, the two instruments usually applied to fixing the places of the stars, their positions being the fundamental points of astronomy. One of those instruments, the Transit, formed the most perfect check upon time-keepers. The second subject was the Telescope, as the foundation of all optical instruments used in astronomy. It would be desirable, notwithstanding many present were well acquainted with the subject, to begin with its rudiments.

If they went out on a fine night they saw the sky studded with stars, apparently innumerable, but which were ascertained by accurate calculation to amount to from 1200 to 1500 in our hemisphere, and to about 4500 in both hemispheres. Among them were a few very bright ones, which by careful observation were found to move, but the rest retained their fixed relative positions, forming constellations. There was, however, an apparent motion in all. The motions of them, if carefully watched during a long night, would have the effect of lines on a shell or spherical concave vault. The Moon also rose and set among the stars, and in the day-time the Sun also. That must either arise from all being, as it were, connected and moving

together, or the Earth must rotate on its axis in 24 hours, and so bring all into view successively. The latter was found to be the true explanation. If watched carefully, the paths of the stars were seen to form circles round a fixed centre, which was called "the Pole." That was an imaginary point; but a large star near it was called the "Pole Star." Its position was shown by two stars in the conspicuous constellation of the "Great Bear," a line drawn through which would, if produced, pass very close to the Pole Star; for which reason they were called "pointers." There were certain stars which described circles so close to the pole that they never passed below the horizon in certain latitudes. These were called "circumpolar stars," and their number increased as the pole was approached. After pointing out by the aid of diagrams the stars visible at the north pole, the equator, and the south pole, the Lecturer explained the method of using the celestial globe for a similar purpose. The stars were equally present by day as by night; although needing the assistance of telescopes to enable them to be seen. All the stars were suns shining with their own light. The sun appeared to move among them, but it was the earth that travelled, and would appear from the sun to be among the stars seen at night.

The sun did not appear to go round the earth exactly in the same time that the stars did; it was, therefore, seen in different parts of the heavens at different times, and by its light obscured different stars. That change of place was a gradual one. The stars gained upon the sun four minutes per day, and two hours per month; thus bringing different groups into view successively.

The attempt to group the stars into definite forms for the purpose of identification and classification was made at a very early period. Many of the constellations now recognised could be traced back to the time of the Argonautic Expedition, 1200 years before Christ. Aratus, who lived 370 years before Christ, gave 45 constellations, which, with the addition of three, were identical with the 48 enumerated by Ptolemy, who flourished 170 A.D. Job was regarded as contemporary with Moses, and certain constellations are mentioned in his writings, which although not rendered quite exactly in the authorised translation, gave sufficient evidence of the recognition of that method of grouping stars at that early period. Homer and Hesiod also, 950 years before Christ, spoke of the Hyades and Pleiades. Catalogues of the stars had been made at various times, specifying their places. Hipparchus (120 B.C.) formed one of 1080. That was extended by Ptolemy to 2000. Most of the old groups or constellations were still used, although some added thereto within the last 200 years had been dropped.

Stars were distinguished by their "magnitude." That word simply meant their brightness, for those which thus appeared the largest were probably the nearest to this earth, although that was not a universal rule. Six different magnitudes could be seen with the naked eye, and sixteen or eighteen with the telescope. The stars were distinguished in order of brightness in each constellation by the letters of the Greek alphabet, and by numbers, and some of the larger ones were known in addition by proper names.

The heavens were crossed by several imaginary circles. One was the equator, or "equinoctial;" another was "the ecliptic," or the Sun's apparent path, which was that of the Earth in reality, and was inclined to the former 23½ degrees. The ecliptic was divided into twelve parts, each of which was distinguished by a constellation. These were known as the signs of the zodiac. The points where the equator and the ecliptic crossed were called the equinoctial points. The meridian was a great circle joining the two poles. It was not fixed, but each place had its own meridian, which passed through its zenith, or the point of the heavens exactly overhead.

It was necessary to ascertain exactly the position of the fixed stars, in order to have fixed points of reference for observing the motions of the planets. That was done, in the first instance, by a Transit instrument. The elements desired were the latitude and the longitude—in other words, right ascension and declination. It was essential, in order to ascertain the exact position of any point, to have two elements—such as the height from one point, and lateral departure from another. These were the co-ordinates. Right ascension was the distance along the equator from the first point of Aries, which was one of the two places where the ecliptic intersected that circle, and answered to terrestrial longitude. Declination was the distance north or south from the equator, and answered to latitude. The right ascension was found by the transit instrument, used to determine how far the earth really, or the heavens apparently, had to turn from the first point of Aries to the star in question.

The Transit instrument was a telescope fixed in the meridian, and so mounted on pillars, or a stand, as to admit of being turned from North to South, but not from East to West. It had a series of five or seven parallel wires, or "spider lines," arranged in front of the eye-piece in such a manner as that they might be distinctly seen at the same time as the star. A clock was essential for use with the transit. The method of using it was to fix the instrument in the proper position for declination, and watch until the star entered the field. The instant of its passing over each wire was noted, and a mean of the whole was taken and gave the right ascension in time, which was the result required—namely, sidereal time. At night it was necessary that the wires or spider lines should be illuminated. That was effected by means of a lamp placed at one end of the axis, which was hollow, and allowed the light to strike on an annular mirror, placed at an angle of 45 degrees across the tube of the telescope. That reflected the light upon the wires in such a manner as to render them just visible, without preventing the vision of the star.

Prior to taking a transit, several adjustments were necessary. The telescope must first be adjusted to a perfect focus for the stars, and the eye-piece must also be adjusted to a focus for the wires. The three great adjustments were,—First, levelling. The spirit levels used were of two kinds, and of a large size; one of them was called a striding level, from its being placed over the axis, and the other was a hanging level, being suspended to it. The supports of both were made to bear upon the pivots of the axis, which were very truly and accurately turned. When the position of the air bubble was ascertained, the level was reversed end for end, and again noticed. If the level was known to be exact, the necessary alterations were made by the screws which elevated or depressed the axis only; but if it was not certain whether it was exact or not, the error was half altered by the transit screws, and half by the screws attached to the level. These operations were repeated several times, until the axis was absolutely level. The second adjustment was for collimation, or to ascertain that the tube was at right angles to the axis, and that the centre wire was in the optical centre of the telescope. That was effected by noticing some stationary mark through the instrument, such as the corner of a chimney-pot, a crack in a wall, or a white mark, as a watch-dial, put in some convenient position, and then reversing the axis end for end. The plate carrying the wires was adjustible from side to side, and was moved to a distance equal to half the error; the other half was altered by the azimuth screw of the transit. The next adjustment was to ascertain that the instrument moved exactly in the meridian. There were several ways of doing that. The pole star described

a circle in the heavens, and passed the meridian twice in twenty-four hours, once above and once below the pole. Each transit was observed; and if they were exactly twelve hours apart, the circle described by the star was exactly divided, and the instrument was truly in the plane of the meridian. That method required a clock which would keep a good rate, and also an instrument large enough to show the star by daylight. The second method was by the transits of two stars of nearly the same declination, but twelve hours different in right ascension; the transit of one above and one below the pole would then happen within a few minutes, and if the difference was the same twelve hours apart, the transit was in the meridian. In that case the clock rate was only important for a few minutes; but two sets of observations were required, and the weather might interfere. Another method was by means of two stars, one high and the other low, varying some 40 degrees in declination. The star near the zenith would give true time if the axis was level, and the other would show the error in azimuth. If the observed difference of the transits was equal to the recorded difference of right ascension, the instrument was in the meridian. For that method the two stars Riga and Capella were good.

The Transit instrument was invented by Romer, who observed the first transit in 1690. His instrument was similar, in most respects, to those now used, except that he used the plumb-line instead of the spirit level.

It would be quite out of place here to describe the construction of the clock; suffice it to say that, for Observatory purposes, it should show sidereal time. A day was the unit of time. It might be either a sidereal or a solar day, and was the space occupied by the rotation of the earth upon its axis. The sidereal day was the real time of the earth's rotation, and was comprehended between the instants of a star leaving the meridian and of its returning to it again. They were, however, compelled to use the solar day, or else the time of meridian would travel backwards from noon to midnight, and so on round to noon again. Solar time was that which was reckoned from one meridian passage of the sun to the next, and was longer than sidereal time, because the earth had moved and had caused an apparent change in the sun's place, but not in the stars; consequently a solar day was nearly four minutes longer than a sidereal day. But the solar day thus measured was not a constant quantity; hence the distinction between mean and apparent solar time. The causes of that irregularity were the inclination of the ecliptic and equator, and the eccentricity of the earth's orbit. The latter made the earth move faster at its perihelion, or nearest point to the sun, and slower at the opposite side of its orbit. It was therefore necessary to assume a *mean* sun, as it was called, moving in the equator at the average rate of the real sun in the ecliptic. The time between two transits of that imaginary sun constituted a mean solar day. The difference between true and mean time was called equation of time, and was generally given in almanacks. There were four extreme points—viz., Feb. 10, when the sun was slow 14m. 32s.; May 15, 3m. 54s. fast; July 6, 6m. 11 s. slow; and Nov. 18, 16m. 17s. fast. The difference between Greenwich mean time and solar time was simply the difference of longitude. Sidereal time was used in the Observatory, as it simplified the operations of observing, and of recording observations.

They thus saw how the Transit instrument, by fixing and ascertaining the right ascension of stars, checked the clock; the difference between the observed transits and the tables in the Nautical Almanack constituting the clock error, as the stars must be right, while the daily alteration gave the rate.

The declinations of the stars were measured, in the first instance, by a large instrument called a "Mural Circle," from its being fixed to a very solid wall of masonry. It was a telescope fixed to a large graduated circle, which moved on its centre, attached to the wall. It was invented by Troughton; and as extreme accuracy was necessary in the results obtained, the divisions of the circle were read off by means of microscopes, a method best adapted to eliminate all possible errors of division. The declination was measured from the equator; but as there was no real line there, the fixed point was obtained indirectly by starting from the pole. That was first obtained by getting the exact zenith, which was effected by reflection in a surface of mercury.

The Lecturer proceeded to describe the great Transit at the Greenwich Observatory, of which a model exists at the South Kensington Museum, and also to describe the machinery connected with the Time-ball. In conclusion, he adverted to the changes and improvements likely to take place by the further developement of the system of transmitting time signals by means of electricity.

[On a future occasion we hope to give a detailed account of the instruments and work done at our great National Observatory, which, we are proud to say, stands first in the rank amongst astronomical establishments.—Ed. H. J.]

SECOND LECTURE

Continuation of the Subject—Astronomical Instruments.

By Mr. T. W. Burr, F.R.A.S.

The Lecturer commenced by alluding to the relation of the subject to Horology, and then proceeded to state that the word "telescope" was derived from two Greek words, τηλε, *distant*, and σκοπέω, *I look at.* It was somewhat difficult to fix the precise date of the invention. Some of the optical laws on which its principles of construction are based were known to the ancient Greeks, and Roger Bacon at a later date spoke of magnifying objects and bringing them near. Baptista Porta spoke of the magnifying powers of convex and concave surfaces. Although Thomas Digges stated that his father, Leonard Digges, made such instruments, there was no proof that any existed until 1608, when some were made in Holland. There were several claimants for the honour of the invention. Lipperhay, Jansen, and Metius, of Alkmaar, severally disputed the priority. The discovery was accidental on the part of one at least of these; Jansen's children accidentally discovered that, by placing two spectacle lenses at a distance from each other and looking through them, they brought the weathercock of a neighbouring church nearer to them. Jansen at once fixed some lenses to boards, and presented this rudimentary telescope to his patron, Prince Maurice. Galileo, the great astronomer, heard of the invention, and reflecting on the known laws which govern the rays of light in passing through transparent substances, proceeded to contrive a similar instrument. This telescope was exceedingly simple, like other great inventions. It consisted of one lens or magnifying glass next the object whence it was called the *object glass*; the rays of light from the object passing through this glass formed an image at its focus, and this image was examined through another lens, called the *eye-glass*, or eye-piece. If a lens was placed before the flame of a lamp or candle, and a screen of paper or ground glass were placed at a certain distance behind it, it would be found that the rays from the flame passing through the lens would be condensed upon the screen, and an

inverted image of it would be depicted there. Now this image existed, whether the screen were there or not; and if another lens was used at the proper distance, the image so formed would appear magnified. The size of the image depended upon the distance between the object and the lens: the farther they were apart, the smaller would be the image.

The term "magnifying power" is often much misunderstood. A magnifying glass simply enables us to approach the object closer, and to view it when it subtends a larger angle to the eye. The distance at which ordinary vision was best is 10 inches. If the eye be approached nearer, the image is confused, from the rays not meeting on the retina; but the interposition of a convex lens converges them sooner, and brings them to the right place. Another effect of the lens is to collect a larger number of rays than would otherwise enter the eye; hence objects too faint to be seen by the unassisted vision are seen by using a telescope.

There were two kinds of telescopes—refractors and reflectors. Refractors were composed of lenses, or glasses; and mirrors or specula were used in reflectors.

There were two kinds of refracting telescopes—the Galilean and Keplerian. Galileo made use of a convex lens for the object glass, and a concave one for the eye-glass. In this case the eye-glass was placed within the focus. That telescope was of a low power, and had a small field, limited by the pupil of the eye. Galileo's highest power was 30. That construction is now used chiefly for opera glasses. Kepler suggested the present form of the astronomical telescope. In this instrument the rays were first converged to a focus, forming an image there, and the eye-piece was then employed to view the magnified image thus produced. The chief advantages of this telescope were found in the increased size of the field, in its higher magnifying power, and in the convenience which it offers for placing the micrometer wires so that they might be seen at the same time with the image of the object. The arrangement and use of these wires were described in the last lecture.

The first telescope on Kepler's plan was made by Scheiner. Great discoveries had been made by the use of the astronomical telescope. By it the remarkable phenomena presented by the Moon, the configuration of its surface, its mountains, valleys, and craters had been made known. In January, 1610, the moons of Jupiter were discovered by its aid, thus confirming the Copernican theory. The spots on the Sun, and the phases of Venus, had been discovered by it, and the remarkable changes in the appearance of Saturn were explained. That planet had sometimes seemed to be a group of three bodies—one on either side of a large central mass; at other times it looked like a globe with handles, and again it appeared olive-shaped. These various phenomena were at length explained by Huyghens, who found that the planet is surrounded by a flat ring.

There were two grand defects in the early telescopes: one arose from spherical, and the other from chromatic aberration. The former defect was due to the rays passing through the edge and those through the centre of the lenses not meeting at the same point, those from the edge converging sooner than those from the centre. The result was the formation of a succession of images, and a cloudy appearance surrounding the object. One remedy for this evil was by cutting off the edge of the lens by the use of a stop smaller in its aperture than the lens itself; but this plan reduces the light. Another method of correction was by grinding the surfaces of the lens to two different curves; the best proportion being as 1 to 6, which was found to produce the least possible aberration. The eye-piece was also found to be subject to the *same defect;* but Huyghens contrived a form to *remedy this, which goes by his* name. He employed two lenses of a plano-convex shape, and mounted these with their convex surfaces next each other. The effect of this arrangement was to diminish the aberration, and increase the distinctness of the object. Another method of reducing the error was to employ object glasses of small curvature, and consequently of long focus, with an eye-piece of low power. Hence telescopes have been constructed with lenses of 90, 130, 170, 210, and even 300 feet in focal length. Of course, in these cases it was impossible to mount the glasses in tubes; but the object glass was fixed at the end of a long pole, and worked by a cord so as to bring the star into its field. Huyghens presented a glass of 123 feet in focal length to the Royal Society. It had recently been proposed to remount this lens; but it had been found that the expense (£400) was too great in comparison with the results to be obtained. By the aid of these telescopes Huyghens discovered Titan and five other satellites; he also ascertained the axial rotation of Mars, Jupiter, and Saturn, and the elliptical forms of Saturn and Jupiter.

Notwithstanding these results, the telescope was still an imperfect instrument. Although its spherical aberration had been got rid of by the means before alluded to, there still remained *chromatic* aberration. Light, in passing through a lens, is not only bent, but the ray is decomposed or broken up into colours. This was shown in the simplest manner by using a triangular prism. If a ray of light from a hole in the shutter of a darkened room was intercepted by such a prism held at a certain angle, it would be bent out of its course, and would strike the wall at a different place to what it would otherwise have done, and would produce upon the wall a band of different colours, called the *prismatic spectrum.* This is composed of three distinct colours, and four shades of colour caused by their overlapping each other. All lenses are prisms of a circular form, and the images produced by them are consequently surrounded by coloured fringes. Sir Isaac Newton, who discovered this composition of white light, thought that he might combine different substances, so that coloured bands of different lengths might correct one another; but he failed in the attempt, and therefore gave up the refractive principle as inapplicable to telescopes, and invented reflectors. James Gregory had suggested the same idea in 1663, and had tried to make his speculum of a parabolic form, as giving a truer image. In this he failed; but Newton conceived that a surface composing part of a sphere might succeed.

Having shown by experiment how the image was formed by a concave mirror, the Lecturer proceeded to say, that in 1671 Newton made two reflecting telescopes with his own hands. He used a concave speculum, and a small plane mirror to receive the image, which was then examined by an eye-piece. In the Gregorian telescope the large speculum was perforated, and the rays being received upon a small concave mirror, the rays were sent back to the eye through the opening in the former. In the Cassegrainian, another form of telescope, the second mirror was convex. One of Newton's telescopes was at present in the possession of the Royal Society. It was 6½ inches long, and it magnified 38 times. The Herschelian form of telescope possessed no small mirror, which prevents much loss of light. Light was reflected without decomposition, but much of it was absorbed, amounting in some cases to one third of the whole, while only 1-20th was lost by using the refractive principle. Hadley and Short were two makers who were celebrated for these reflecting telescopes. They increased the size of the speculum—a point of immense importance, as the light, and consequently the distinctness of the object, increases as the square of the diameter.

But though Newton had given up the idea of

getting an uncoloured image by means of telescopes constructed on the refracting principle, others were more successful. It appears that Newton made some mistake in trying the effect of a glass prism combined with water, and was thus misled in his conclusions that the parallel ray obtained by this combination would be uncoloured. In 1747 Euler proved that this could not be; and John Dollond, of Spitalfields, struck by the obvious contradiction, tried the experiment for himself. Dollond was of French extraction; he had been a weaver, but was a good mathematician. He found that Euler was right in his conclusions; and proceeding in the same direction with his experiments, he next tried a combination of flint and crown glass. He thus found that the refractive or bending and the dispersive or decomposing powers of these two materials were not in the same proportion, and that he could thus correct colours without entirely losing refraction. About 1760 he made an achromatic telescope, being guided in his proportions by the humours of the eye. Euler also referred to the same illustration; and in 1739 a Mr. Hall had made such a telescope, but never exhibited it. The object glass of an achromatic telescope consisted of a convex crown and a concave flint lens, or two convex and one concave lenses. The concave flint diverged the converging rays, but did not destroy the focus, it only lengthened it. But the dispersive power was so much greater, that while the convex or crown glass threw the red ray beyond the violet, the concave drew it back again upon the violet, and so reproduced white light. Dollond's telescopes were very excellent, and his discovery restored the use of the refractive principle. One of five feet in length proved equal to any telescope then made, and was much lighter and smaller.

The astronomical telescope inverted the image of the object, but the introduction of two more lenses in the eye-piece erects the picture, and gave a day telescope.

The practical difficulties in the way of constructing achromatic telescopes were numerous. Flint glass often possessed striæ which caused distortion, and which were not apparent till the lens was ground and polished. Dollond had some fine samples of flint glass, but he only made lenses of 3¾ inches in diameter, with a few of 5 inches.

A fresh impulse to telescopic discovery was given by Sir W. Herschel. That celebrated man was originally a musician, having been an organist at Bath. He was partial to the study of astronomy, and wanting a telescope, and finding them dear, he made one for himself. In the course of time he acquired great facility in the construction of reflectors, of which he made as many as 200, of 7 and 10 feet long, and sold them at high prices. One of his important discoveries was that of the planet Uranus, which he first saw on the 13th of March, 1781, among the smaller stars in the constellation Gemini, and observed that it formed a disc instead of a point of light. He used a 7-feet reflector, and thought the object was a comet. He observed it till the 19th of April, and thus proved its motion, when he communicated his discovery to the Royal Society. The French geometricians could not make out the parabolic orbit peculiar to a comet, and Maskelyne suggested that it was a planet with a nearly circular orbit. The names Georgium Sidus, Herschel, and Uranus were given to the new planet by different authorities. Its size was 35,000 miles in diameter, and it possessed several satellites, some of which were discovered by Herschel and his son, and some by other astronomers.

Herschel subsequently made a reflecting telescope of 30 feet focal length, and with it entered upon researches on double stars and nebulæ. A few double stars had been previously known to Hooke, Halley, Flamstead, and Bradley. The optical theory formed for their appearance was, that they were individual stars, one behind the other, in a line, but at a great distance. Herschel observed them with the object of ascertaining parallax, but found that the number of double stars was so great that the arrangement could not be accidental. Accurate measures of their position soon detected a rotation of one around the other, in various periods, varying from 43 to 1200 years. This discovery was a grand one, inasmuch as it extended the influence of the power of gravitation far beyond our system into the celestial spaces.

Herschel also investigated the nebulæ, certain curious cloudy patches only visible to telescopes, and similar in appearance to the milky way. Herschel thought they were of two kinds—one resolvable into stars, and the other merely consisting of luminous matter. On this supposition a theory was built; but, one after another, these luminous mists have been resolved into clouds of stars by the application of higher telescopic powers. The Lecturer pointed out by means of diagrams the peculiar appearances of many of these nebulæ.

Herschel was patronized by George III., who found the money for a 40-feet telescope, which gave an immense amount of light. By it the satellites of Saturn were discovered. Sir John Herschel continued the use of reflectors; but about 40 years ago large refractors began to be used. Frauenhofer made one of 9-inch diameter at the Dorpat Observatory, which was quite equal to a 20ft. reflector, and Struve used it for his catalogue of 3000 double stars. Some large French glasses had also been made. Sir James South possessed one of 12-inches in diameter; and one very fine one existed at Cambridge, which was set up in 1808 and used in the search for Neptune. There was also one of 15 inches diameter at Pulkowa, in Russia, and one at Cambridge, U.S., both by Merz of Munich.

Reflectors were now again resorted to, and the specula, being made of a better form and polish, more excellent results were obtained by them. M. Lassell had constructed one of 3 ft. diameter, with which valuable observations had been made, as well as by many others. All these were, however, eclipsed by the telescope of Lord Rosse. The first that he made had a speculum of 3 ft. diameter, and subsequently he had constructed one of the enormous size of 6 feet, and weighing 5 tons; it was 54 feet long, and was mounted between two massive stone walls. The observations made by this enormous instrument, on the nebulæ especially, had given a far more extensive notion of the universe than had before existed. On a moderate calculation the light must take 60,000 years to travel from many of these nebulæ to the Earth. If, travelling with the speed of light, we were to pass but to our Moon, thence to the Sun, and so on to the nearest star, we should still see the same heavens; and, continuing our journey with like speed for hundreds and thousands of years, we might at last come out into space, but we should then commence to approach some one of these nebulæ—another galaxy of stars like our own. Rushing past this, we should find others dotted in space like the sand or pebbles on the sea-shore. The number of these systems of stars already seen by Herschel was 350,000, and Rosse had observed ten times as many.

The Lectures were copiously illustrated by diagrams, and also by models of the Transit instrument, Mural Circle, and Telescope; and attention was also drawn, in the last Lecture, to a new adaptation of a method of precipitating pure silver upon glass to making specula for telescopes, which seems to promise well.

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

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(*Continued from page* 127.)

1792, June 12.—No. 1889.

LITHERLAND, Peter.—1. Improvements in escapements, by which watches are made to beat once only in a second, and also to point dead seconds.

2. An instrument to counteract the effect of heat and cold. A steel bar is fixed on the same centre as that on which the regulating spring acts. There is a convex brass spring to this bar, with a notch in it near the middle, so that when it expands it produces a greater curvature and lays hold of different parts of the regulating spring; and vice versâ.

3. Winding up watches, &c., without a key, by means of an external lever connected by mechanism with the barrel arbor.

[Printed, 9*d.*]

1793, March 15.—No. 1936.

COLE, Richard.—1. An escapement, for beating, striking, and pointing seconds or parts of seconds. May be either vertical or horizontal. The vertical wheel has fifteen teeth, and goes round twice in a minute. It acts on the verge, on which is fastened the pendulum spring and the verge wheel having ninety-six teeth; twenty-four of which, acting in a pinion of six teeth, turn the balance four times round every beat. In the horizontal escapement the horizontal wheel of fifteen teeth acts in a cylinder to which is fastened the regulating spring and the cylinder wheel of ninety-six teeth, which cylinder wheel acts as the verge wheel mentioned above. In both the number of teeth in the wheels and pinion may be varied according to the number of beats required in one minute.

[Printed, 6*d.*]

1793, December 13.—No. 1970.

LESLIE, Robert.—Relates to the following:—

1. A short pendulum to vibrate seconds. Two weights are connected by a bar, and the bar suspended by two springs, the upper ends of which pass through a bar screwed to the back plate of the clock. The clock is regulated by these springs being moved nearer or farther apart by means of a screw. Instead of the weights and bar, a wheel is sometimes put.

2. A rolling pendulum, consisting of a piece of metal of any diameter, having turned round it two small grooves, which receive two parallel springs *supported by a frame*. The clock is regulated by the *tightening or slackening of these springs*.

3. A regulator for clocks which has the properties of the "gridiron pendulum." A brass wheel has a groove round it which receives a watch spring, one end of which is fastened to the wheel, and the other, after one or more turns round the wheel, as the length of the pendulum requires, passes down to the rod. One edge of the wheel is left high enough for teeth for the regulating screw to act in.

4. A scapement. The motion is given to the pendulum by two springs, each having one end fastened to a roller, and the other to one of the pallets. The wheel acts on these, and raises them alternately.

5. A scapement. A lever is pressed against the scape wheel by a spring, which, by a pin, also prevents the wheel running. On the arbor of the balance is a pallet which receives the impulse from the prong of the said lever. The lever is held up by a spring, until a small pin on the said pallet disengages it; the lever then falls through the influence of the first-mentioned spring, strikes the pallet with its prong, and then with its long arm releases the pin which prevents the scape wheel from running. A tooth is thus allowed to escape, when the lever is brought back into position ready for a similar motion.

6. The striking part. On the great wheel is a plate with notches to determine the number of strokes in the common way. The hammer is raised by pins on a star wheel, by whose points acting on the balance arbor the balance is regulated. The hammer makes one stroke every second vibration, and when all are struck, the whole is stopped by one end of a lever falling into one of the notches, and the other against a pin on the rim of the balance.

7. A method of determining the number of strokes in repeating clocks. A wheel with seventy-two teeth, having on its side a pin at every twelve teeth, is moved one tooth every hour. A click on the rack stops against those pins. The regulator of the striking is a hollow box made like a spring barrel and put on the arbor of the pinion which moves the rack; the box has a division from its centre to near its rim on one side, and there is a quantity of sand put in, which has to pass every revolution through an aperture: the velocity is determined by the quantity of sand, or the size of the aperture.

8. A nautical clock with two dials; one to shew "the time at the place sailed from, and the other the "time of the present place."

9. A method of giving motion to a balance without friction. A lever is fastened to one end of the cylinder: one end turns up, and passes through a hole in the upper frame plate; this end has a hole to receive the balance spring at the distance of about one turn from its outward end; the inward end of the balance spring is fastened to a collet on the arbor of the balance, while the outward end is fastened to a stud in the plate. By giving motion to the cylinder, and the lever on it, and thus moving the spring, motion is given to the balance.

10. The repeating part. The stroke is regulated by a balance instead of the train of wheels in other watches. To make the watch repeat, the rack is pushed down by the pendant, and is urged back by a

spring which has power equal to the main spring in other watches. As the rack returns it acts on the hammer tail to draw the hammer in, and is prevented from doing it too quickly by a small spring which acts on the arbor of the balance as a scapement, which turns the balance till it passes through a small notch in the arbor; the rack then slips off the hammer tail, but is prevented from flying all the way back by a spring which the stroke of the hammer disengages, and the rack again falls on the hammer for another operation. When the hour is struck, a pin in the end of the hour rack takes hold of the quarter rack, to strike the quarters. The sound of the quarters being struck is made to differ from that of the hours.

11. A mainspring for clocks, watches, or timekeepers of any kind. The spring, which may be a square bar of requisite thickness, is bent round the movement outside the pillars, and between the frame plates. Where the two ends meet, they press against a stud fastened to one or both of the plates. The middle of the spring is cut in a peculiar form, and is acted on by a piece fixed on the rack, "on the "principle of the spring and tumbler of a gun lock."

12. A method of winding up a watch by the pendant. On the square where the key should go is a ratch; the pendant, being alternately moved in and out, turns this ratch by means of two clicks on either end of a fork fastened to the pendant.

[Printed, 1s. 3d. See Repertory of Arts, vol. 2, p. 92.]

1796, August 17.—No. 2132.

HALEY, Charles.—A helical renovating spring with certain apparatus placed between the balance wheel and balance, which is wound up 150 times in a minute. The renovating spring is so placed that its axis, the axis of the balance, and the balance wheel, have their centres all in the same right line. On the axis of the renovating spring is a round pallet, in a notch on the edge of which the teeth of the balance wheel act, and thus wind up the renovating spring. The renovator is prevented from unwinding by a spring (which is so made that the discharging pallet on the axis of the balance will pass by when going one way, but when returning will not do so) catching behind what the patentee calls the "snail pallet," which snail pallet is just above the round pallet, and, as well as its former purpose, serves the purpose of locking the next tooth of the balance wheel. On the axis of the renovator is "the impelling pallet" to give impulse to the balance by striking on a pallet on the axis of the balance. Suppose the discharging pallet to have passed the detent spring; the balance on returning removes this spring, thereby releasing the snail pallet, and consequently the renovator; the impelling pallet flies round and gives the impulse to the balance, and immediately after the snail pallet unlocks the balance wheel, the next tooth of which again winds up the renovator by acting on the round pallet, the detent spring prevents it from being unwound until the discharging pallet of the balance has passed by on its return, when a similar operation takes place. The spring may be a spiral having all its coils in the same plane, or in the surface of a cone or cylinder. The patentee does not confine himself to any particular number of beats per hour.

[Printed, 11d. See Repertory of Arts, vol. 6, p. 145; and Smith's Mechanics, vol. 1, p. 496.]

1796, November 24.—No. 2148.

TRUSTED, Charles.—A timepeater to strike the hours and quarters. The hour barrel is a barrel with a wheel fixed to it, on which are twelve pins to strike the hours, and on the cylinder part of the barrel are twelve pins diagonally placed in two arrangements, to stop against a stud fixed in the sliding rack; this stud governs the number of strokes. To tell the hour of the night, a brass wheel with a corded edge, which is screwed upon the end of the barrel arbor, must be turned backward until the stud stops against such of the pins as corresponds with the hour, and then must be turned gently forward, and the hammer will strike the proper hour upon the bell. The aforesaid sliding rack has 24 teeth, and is worked by a pinion of 10 teeth in modern or flat watches, and of 8 teeth in old watches, where 6 turns of the fusee are required. On the outside of the rack are 12 divisions for the 12 hours. To set the machine in the evening, the graduated divisions of the rack must be set to correspond with the hour.

When there is a quarter barrel, the hour barrel must be made longer. After the last stroke of the hour is struck, the hour barrel communicates the acting force to the quarter barrel by pins acting against each other. The quarter barrel is very similar to the hour barrel; the pinion and rack being respectively of 20 and 48 teeth in modern or flat, and of 16 and 48 teeth in old watches.

[Printed, 7d.]

1798, December 17.—No. 2280.

PECKHAM, John Randall.—A mariner's compass is inserted in or upon the face of the dial. To prevent the works of the watch and the magnetic needle affecting each other, all the works usually made of steel, and for which steel is not absolutely necessary, are made of gold, silver, or any other metal or admixture of metals which have no influence on the magnetic needle.

[Printed, 3d. See Rolls Chapel Reports, 6th Report, p. 147.]

1801, February 17.—No. 2482.

BENNOCH, John.—The title of the invention is, "New and expeditious methods or machines for mak- "ing nails, bolts, rods, watch springs, clock springs, "and metal plates." The machine seems to be principally for the manufacture of nails.

[Printed, 11d. See Rolls Chapel Reports, 6th Report, p. 200.]

(To be continued.)

MEETINGS OF THE
British Horological Institute.
FOR JUNE.

Tuesday, June 7.—LECTURE, at 8½ P.M., at the Amwell-street School-rooms,

On the Detached Lever Escapement, with some Introductory Observations on the Principles and Construction of Chronometers, Pocket Watches, and other Timekeepers.

By Mr. JAMES F. COLE.

SYLLABUS.—Natural Laws referring to Motion, Elasticity, Force, and Resistance.—Outline of general Construction of the Chronometer and Watch Movement.—Brief notice of various Escapements.—Extracts from Manuscript Paper, on Diameter, Weight, and other Properties of the Balance, and on the Principles of the Detached Lever Escapement, with his Improvements on the same, known as the Resilient Lever. The effect of this original principle is a complete remedy of the detrimental influences of external motion on the otherwise correct performance of Lever Pocket Watches, as deduced from his prior inventions of Double Rotary Escapements for correcting errors from the same influences on Chronometers and Duplex Watches.

Tuesday, June 21.—The ANNUAL MEETING at 8 P.M., at the Offices, 35, Northampton-square,

To receive the Report of the Council for the past year, and to elect Officers.

TO CORRESPONDENTS.

"A MEMBER OF THE HOROLOGICAL INSTITUTE" will perceive that we have anticipated his wishes with respect to the Lectures.

Y.—A full account of the Harton Colliery Experiments is published by Messrs. Longman, in the form of a Lecture delivered at Shields by Professor AIRY. The experiments have also been fully detailed in the "Philosophical Transactions."

"A COUNTRYMAN" would find it better to obtain some Manual of the Electro-gilding process, which would furnish him with more information than could be conveniently conveyed in the pages of this Journal. Walker's "Electrotype Manipulation" is a good one.

DECLINATIONS of the following STARS, and Times at which they are on the Meridian at Greenwich, for June, 1859.

Name of Star.	Day of Mon.	Dec. North	Greenwich Mean Time of passing the Meridian.
		° ′ ″	h. m. s.
a Bootis (*Arcturus*)	10	19 54 54·0	8 54 34·04 P.M
	20	19 54 55·5	8 15 14·84 „
	30	19 54 56·4	7 35 55·63 „
a Ophiuchi	10	12 39 46·6	0 13 11·25 A.M
	20	12 39 48·6	11 33 51·22 P.M
	30	12 39 50·5	10 54 33·16 „
a Lyræ (*Vega*)	10	38 38 67·2	1 20 42·99 A.M
	20	38 38 70·3	0 41 24·00 „
	30	38 38 73·4	11 58 8·98 P.M
a Aquilæ (*Altair*)	10	8 29 52·3	2 32 15·61 A.M
	20	8 29 54·4	1 52 56·70 „
	30	8 29 56·6	1 13 37·77 „

EQUATION OF TIME TABLE
For JUNE, 1859.

Day of the Week	Day of Mnth	At APPARENT NOON — Equation of Time to be *subtracted* from Apparent Time.	Difference for One Hour.	At MEAN NOON. — Equation of Time to be *added* to Mean Time.
		m. s.	s.	m. s.
Wed..	1	2 33·14	0·380	2 33·12
Thurs.	2	2 24·03	0·396	2 24·01
Fri. ..	3	2 14·53	0·411	2 14·51
Sat. ..	4	2 4·66	0·425	2 4·65
Sun. ..	5	1 54·46	0·438	1 54·45
Mon...	6	1 43·94	0·450	1 43·93
Tues..	7	1 33·11	0·462	1 33·10
Wed ..	8	1 22·02	0·473	1 22·01
Thurs.	9	1 10·66	0·483	1 10·65
Fri. ..	10	0 59·06	0·492	0 59·05
Sat. ..	11	0 47·25	0·501	0 47.24
Sun. ..	12	0 35·22	0·508	0 35·22
Mon...	13	0 23·02	0·515	0 23·02
Tues..	14	0 10·66	0·521	0 10·66
		added to Apparent Time		*subtracted* from Mean Time
Wed ..	15	0 1·85	0·526	0 1·85
Thurs.	16	0 14·48	0·531	0 14·48
Fri. ..	17	0 27·21	0·535	0 27·21
Sat. ..	18	0 40·04	0·538	0 40·03
Sun. ..	19	0 52·94	0·540	0 52·93
Mon...	20	1 5·89	0·541	1 5·88
Tues..	21	1 18·86	0·541	1 18·85
Wed ..	22	1 31·84	0·540	1 31·83
Thurs.	23	1 44·81	0·538	1 44·79
Fri. ..	24	1 57·72	0·535	1 57·70
Sat. ..	25	2 10·58	0·532	2 10·56
Sun. ..	26	2 23·35	0·527	2 23·33
Mon...	27	2 35·99	0·521	2 35·97
Tues..	28	2 48·49	0·513	2 48·47
Wed..	29	3 0·83	0·505	3 0·80
Thurs.	30	3 12·96	0·497	3 12·94

TO ADVERTISERS.

As a Special Paper, published monthly and intended to become a work of reference, THE HOROLOGICAL JOURNAL will be found to possess advantages to the Chronometer, Watch and Clock-making Community unrivalled for cheapness and efficiency.

N.B. All Advertisements to be inserted in the Journal must be received before the 25th of the month.

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ANNUAL MEETING OF THE BRITISH HOROLOGICAL INSTITUTE.

The Annual Meeting of the Institute was held at the Offices, Northampton-square, on Tuesday evening, June 21st.

Mr. Hislop having been called to the chair, proceeded to state that the object of this Meeting was to receive the Report of the Council for the past year, with an audited Balance-sheet; also to elect the Officers for the ensuing half-year by ballot, together with two or more Auditors by show of hands.

Messrs. Webb, Holdstock, Grimshaw, and Whittaker were first appointed scrutineers of the votes given at the ballot.

Mr. J. Adams, Honorary Secretary, then read the Annual Report, as follows:—

"Report of the Council of the British Horological Institute, for the Year ending June, 1859.

"In conformity with our Rules, and with the usual practice on occasions like that on which we are now assembled, your Council present the First Annual Report of the British Horological Institute.

"In reviewing the transactions of the past year and the progress made, they feel themselves bound to ask that that progress may be judged of with reference to the peculiar difficulties which have beset the path. So new was the project, and so little understood by those for whose especial benefit it was designed, that no small amount of misunderstanding and obloquy had to be encountered by its promoters. But the result which ever follows a steady and earnest pursuit of a good object is now being realized. Many who once misapprehended our design have now become our friends and members, and many others among the most eminent in the trade have, either privately or publicly, avowed their sympathy.

"The number of Members has gone on steadily increasing, and at the present moment amounts to 222; namely, 3 Founders, 14 Life Members, 205 Annual and Half-yearly Members, and 5 Junior Members.

"It is now ten months since the novel experiment of an English Journal devoted to the interests of Horology was attempted by your Council. Ten numbers have been issued, copies of each of which have been supplied gratuitously to the members, and sold to the public at a low charge. It is in the establishment of this Journal that many of our difficulties have been encountered. The subject matter of such a publication must be almost entirely original. The ordinary system on which the pages of a periodical of miscellaneous interest are filled was not available here, and consequently the articles have all been contributed, with one or two exceptions, by the members of the Institute. The result of their labours is before you; and it is for you to say whether the Journal is accomplishing its object, namely, the preservation and diffusion of information hitherto buried or lost for the want of a medium of communication. Your Council venture to express a hope, that the members of the Institute will endeavour, by the further communication of facts, and by interesting discussions, to afford matter for its pages, and that they will also assist in its circulation by promoting its sale among their friends. Already the number taken by the public is nearly sufficient, together with the profits of advertisements, to pay the cost of those supplied gratuitously to the members; and if this number is extended, it will become ere long a source of augmentation to the funds of the Institute.

"Several gratuitous Lectures having been offered, your Council took measures for the delivery of three, during the months of May and June. Two of these were "On Astronomical Instruments and their Uses," by Mr. T. W. Burr, F.R.A.S.; and one "On the Detached Lever Escapement," by Mr. J. F. Cole. It was not thought desirable to prolong the course at this period of the year, but there is no doubt that a continuous series can be organized for the ensuing Lecture season.

"Your Council would call especial attention to the Library, and would press upon the members the necessity of augmenting it by donations and loans. As yet it progresses slowly, but it must be remembered that a good Library will form an essential feature in our Institute.

"The collection of Models and Specimens has increased, and already possesses some interesting examples.

"At an early period it became apparent that the existing laws were not sufficient for the requirements of the Institute. A Sub-committee was therefore appointed to revise and amplify them, and subsequently a Special Meeting of Members was summoned for the purpose of considering the revised code, These laws, so revised, now form the Rules of the Institute.

"Your Council have to record the courtesy and good feeling exhibited towards the Institute by the Court of the Clockmakers' Company,—an ancient corporation entitled to our highest respect from the fact that the names of the most eminent horologists of former times have been connected with it. That body has accorded to us access to its Library and extensive Collection of Models, and has expressed the most friendly sentiments towards the Institute and its objects on all occasions.

"From the Honourable Commissioners of Patents we have also received, by the hands of their Secretary, B. Woodcroft, Esq., the gift of copies of all the Specifications of Patents relating to Horology, with permission to publish as many as we think proper in our Journal.

"We have therefore just reason to congratulate ourselves on the progress made, both in position and reputation, during the first year of our existence as a scientific body; and your Council sincerely express their conviction, that so long as the avowed objects of this body are kept strictly in view, and so long as selfish considerations do not actuate its leading members, it must increase and prosper. By perseverance in the course so plainly before us, we shall attain the position we ought to occupy, and make the British Horological Institute a benefit and a blessing to its present and to its future members."

The Honorary Secretary then read the Balance sheet, which showed a receipt of—Founders' and other Donations, £121. 13s.; Life Members £68. 5s.; Annual and Half-yearly Subscriptions £114. 14s.; Sale of Journal and produce of Advertisements in ditto, £38. 19s. 1½d.; Sale of Lecture Cards, £5. 7s. 8d.; Rent from Mr Palmer, £5.; other Receipts, £1. 11s. Total £355. 9s. 9½d Payments, £291. 19s. 4d. Balance £63. 10s. 5½d.

Mr. SWIFT moved, and Mr. BAKER seconded the adoption of the report, which was carried unanimously.

Mr. ENRIGHT moved a vote of thanks to the Council, which was seconded by Mr. FLETCHER and carried.

Mr. TREWINNARD returned thanks. Their efforts had always been devoted to the benefit of the Institute, and the approval of the meeting would greatly encourage whoever they might think proper to elect to that duty thereafter. There had been many difficulties, but by perseverance they had been surmounted; many more might arise, which would be conquered in like manner.

Mr. E. J. THOMPSON proposed a vote of thanks to the Honorary Secretary, Mr. J. S. Adams, which was carried, and responded to by that gentleman.

Messrs. J. C. Webb, F. Grimshaw, and Holdstock were elected Auditors.

Mr. HUX, jun., proposed a vote of thanks to Messrs. Stoddart, Cole, and Taylor, the retiring auditors.

Mr. MYLNE seconded the resolution, which was carried.

Mr. TREWINNARD, jun., moved a vote of thanks to Mr. Johnson, the Treasurer, to whose untiring exertions the Institute owed its present position. With him it partly, if not wholly, originated. During the three years of its formation and existence he had never been wanting in devotion either of industry or pocket in its behalf. It had been said that the walls of the Institute were adorned by presents from Mr. Stoddart. So had they been by presents from Mr. Johnson. That gentleman had not yet stated all he intended to do in its behalf; and for what he had done, as well as what he intended to do, he was entitled to their thanks.

Mr. HUX, jun., seconded the resolution, which was carried unanimously.

Mr. JOHNSON was not prepared at that early period to return thanks for the honour the meeting had done him. He considered himself placed in a most remarkable position, inasmuch as he thought it an unprecedented proceeding to make the Treasurership annually elective. Still he thought it would secure their interests pecuniarily by the power emanating from the hands of the subscribers returning to them again. It was with pain that he had in that instance to return thanks, as he thought it likely it would be the last time. Mr. Johnson could not see upon what ground this result might take place, and after recapitulating the items of the balance-sheet read by the Secretary, he proceeded to place in that gentleman's hands a cheque for the balance shown by that document to be in the possession of the Treasurer. He distinctly disclaimed any knowledge of the votes to be given by members, and despised the notion of a solicitation or canvass, for if he thought there was only a decent minority against his continuing in the position he held in the Institute, he would much prefer retiring from it.

At 20 minutes to 10 o'clock it was announced that the scrutiny would occupy at least two hours longer; the meeting therefore adjourned until the following evening at six o'clock, to receive their report.

On Wednesday evening the meeting assembled pursuant to adjournment, when the scrutineers presented the following report:—

President (first elected)—

V. Knight, 3, Cornwall-terrace, Regent's Park	115
Charles Frodsham, 84, Strand	26

Vice-Presidents (first three elected)

J. F Cole, 29, Devonshire-street	119
W. Hislop, 108, St. John-street-road	111
J. Stoddart, 13, Red Lion-street	72
C. J. Klaftenberger, 157, Regent-street	40
Charles Frodsham, 84, Strand	40

Treasurer (first elected)

R. R. Hux, 10, Spencer-street	80
E. D. Johnson, 9, Wilmington-square	68

Council (the first-named twenty-eight elected)—

J. S. Adams, 21, St. John-square	132
D. Taylor, 27, Northampton-square	125
J. F. Watson, 21, St. John-square	124
D. Clarke, 8, Goswell-road	123
G. E. Mylne, 2, Great Percy-street	119
Adam Thomson, New Bond-street	118
C. J. Klaftenberger, 157, Regent-street	117
W. B. Crisp, 81, St. John-street-road	116
S. Jackson, Red Lion-street	116
T. Meredith, Charles-street	109
T. Gordon, 34, Great Ormond-street	109
R. Webster, 74. Cornhill	107
V Kulberg, 3, Denmark-grove	104
B. Marriott, 38, High-street, Islington	105
S. A. Brooks, 52, Great Sutton-street	104
O. Gartner, 13, Lower Ashby-street	103
J. Jones, 338, Strand	99
C. Guinand, 129, St. John-street-road	97
R. Schweizer, 28, Bunhill-row	95
J. S. Baker, 14, Great Sutton-street	95
W. Chambers, 18, Powell-street East	94
E. D. Johnson, 9, Wilmington-square	92
T. Swift, 18A, Essex-street	89
C. B. Holliday, 7, Upper Charles-street	79
J. Shepherd, 9, President-street East	79
J. Roberts, 6, Claremont-row	67
J. Trewinnard, 25, Barnsbury-row	57
F. Potter, 12, Upper Ashby-street	51
T. Boothcford, 7, Richmond-grove	50
H. Richards, 2, Charles-street, City-road	46
F. R. Warman, 49, Spencer-street	45
J. Austen, 93, High-street, St. John's Wood	39
J. Purser, 15, Pierpoint-row	28
—Twitchings, King-street, St. Luke's	23

Mr. JOHNSON desired his name to be removed from the list of the Council, as, under the circumstances, he should decline to serve. He would not say a word which should engender discord amongst the members, nor anything that could in any way militate against the interests of the Institute.

The Chairman expressed a hope that Mr. Johnson would not persist in his determination; but that gentleman adhered to his expressed resolution. A discussion of a somewhat personal nature ensued; subsequently to which votes of thanks were passed to the Scrutineers, the Chairman, and the Press, for services rendered to the Institute, which resolutions were severally responded to, and the proceedings terminated.

WHAT IS HOROLOGY?

(*Continued from page* 131.)

Early History of Clocks—*continued.*

Compensation Pendulums.

The successive introduction of the improvements at which we have rapidly glanced in this series of papers, while in great measure accomplishing the objects intended, also brought to light other sources of error not hitherto suspected. The more perfect isolation of the pendulum from the wheel-work and its irregularities, by the introduction of the anchor escapement and its varieties, had enabled it to obey more perfectly the laws which govern vibrating bodies, and thus rendered apparent a source of irregularity for which provision had yet to be made. This arose from the length of the pendulum being affected by temperature, a decrease in which shortened it and quickened its vibrations, while an accession of heat lengthened it and produced a corresponding retardation.

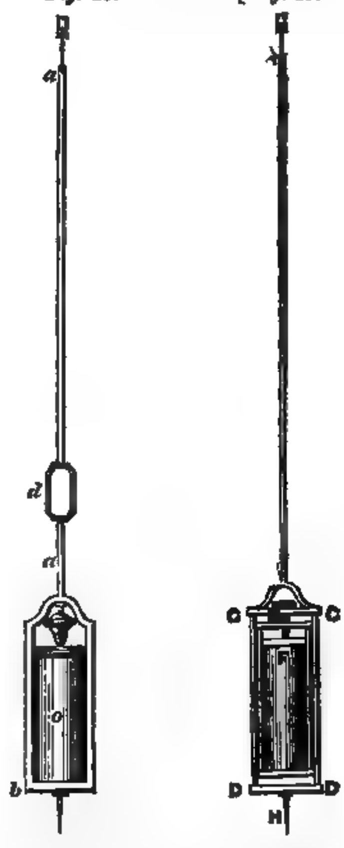
If any substance of sufficient length and size could be found that has not its dimensions enlarged or diminished by heat or cold, such material would be the most suitable for a pendulum. Marble, mica, and glass have at times been proposed, or even used, for the purpose; but none of these are absolutely invariable, while with some we have variations of dimension which are exceedingly difficult to reduce to a definite law.

In a clock with a simple pendulum having a steel rod, every difference of temperature of four degrees will cause a variation of a second per day; the variation with one having a brass rod is nearly twice as much, and with a glass rod not much more than half the quantity. The average difference between the temperature of summer and winter in an inhabited apartment is probably about 25 degrees, consequently the variations of a clock with a steel rod to its pendulum will be in extreme temperatures about six seconds per day, or one minute in ten days.

Probably one of the best materials for an invariable pendulum is baked and varnished deal, or straight-grained Honduras mahogany; but even with this we cannot approach so near perfection as by the employment of the principle of compensation, in which various degrees of expansion or contraction are so opposed to each other as to *compensate* for each other's variations.

The different expansibilities of metals were known to exist as long ago as 1648 by Wendelin; and in 1715 the eminent George Graham turned his attention to the subject. He made a series of experiments with the pyrometer, an instrument invented by Muschenbroek, in order to ascertain the relative quantities of expansion of different metals, with a view of availing himself of the difference between some two of them when opposed to each other for the purpose of compensation. In fact, he suggested the use of alternate bars of brass and steel, as in the gridiron pendulum; but the instrument he employed for ascertaining their relative expansions was so imperfect, and gave so little difference, that Graham gave up the project. It subsequently occurred to him that mercury, by reason of its large comparative variation in different temperatures, was a likely material for his purposes. The object desired was to make the mercury ascend while the rod of the pendulum lengthened, and *vice versâ*. In 1711 he completed and tried a pendulum upon this principle, which is shown in *fig.* 28.

Fig. 28. *Fig.* 29.



It consists of a glass jar, *c*, containing mercury, supported by a stirrup and sole plate *b*, which is itself attached to the lower end of the pendulum rod, *a a*, in the ordinary way.

In the pendulum as made by Graham an auxiliary weight, *d*, sliding up and down the rod was used for timing, but subsequently the

screw and milled head were attached, and the whole stirrup with its included jar of mercury was raised and lowered to bring the whole to time. This altered the position of the index below the stirrup with respect to the division plate for indicating degrees of vibration, and consequently Mr. Adam Reid subsequently introduced the modified form shown in *fig.* 29.

In this pendulum the jar of mercury, F, is carried in an inner frame sliding within the stirrup, and suspended by a screw, E, passing through a bar, *c c*, at the upper part of the latter. By turning this screw the weight is raised or lowered to adjust the time, without altering the relative position of the index point, H, below.

It was thought that the mercury being below the rod, and therefore moving more quickly through the air than the latter, would be sooner affected by a change of temperature, and consequently in an accession of heat, for instance, the rate would be accelerated in the first instance. To obviate this objection, the late Mr. Troughton contrived a pendulum which is nothing more or less than a gigantic thermometer tube, filled to a certain height with mercury. The tube was about the size of that employed for ordinary barometers, and the bulb large enough to contain 45 ounces of mercury. The actual weight or bob of the pendulum surrounds the bulb, and weighs about 9 lb.; at mean temperatures the mercury should reach to the middle of the tube.

The jar which contains the mercury has sometimes been made of iron, the reason given being that it can be made more truly cylindrical than glass, and also for one opposed to that just mentioned, namely, that in consequence of the non-conducting properties of glass, the mercury is affected *later* than the rod. Metallic jars have the objection that the mercury is more adhesive to their surfaces than to that of glass, and if varnished they lose a part of their conductibility.

But a glass jar may be made of such a thickness that the mercury within shall be affected synchronously with the rod; and if it be a little larger than usual, and the rod passed through a tube in its centre with the regulating nut at the bottom, the air will be better able to circulate around it, and consequently the compensating properties of the whole system will be more perfectly adjusted to each other.

The suggestion made by Graham, to use the opposite expansions of different metals, was taken up by Harrison, at that time a carpenter at Barton in Lincolnshire; who invented the gridiron pendulum, so called from *a fancied resemblance of* the arrangement to the appearance of a gridiron. It is composed of alternate bars of brass, *h h*, *d d*, and steel, F, *e e*, *a a*, (see *fig.* 30) the steel expanding

Fig. 30.

Fig. 31.

downwards and the brass upwards, in the proportion of 3 to 5, or nearly so. The bars are so connected together by cross pieces, DB, FC, that the result is, that the centre of oscillation of the whole system remains at the same distance from the point of suspension at all temperatures.

The adjustment of the mercurial pendulum to the precise point where the expansion of the mercury equals that of the rod is effected by withdrawing or adding to the quantity of that metal in the jar,—an operation easily performed, and with very great nicety. The adjustment of the gridiron pendulum, on the other hand, can only be managed by shortening or lengthening one of the series of bars —a process of much greater mechanical difficulty when precision is required.

Soon after Harrison's pendulum was published, Mr. Elliott contrived one which is known as the *lever pendulum*, and is shown in *fig.* 31. It consists of two bars only, one of steel and one of brass. The brass rod is confined to the steel one by screws, *s s s*, passing through slots, so that the brass can slide for-

ward easily when expanding. The ball, *c c*, is made annular, and in the centre opening are seen two levers, F, F, turning on pivots attached to a lateral extension of the steel rod. These levers are unequal, the short ends bearing upon the free end of the brass bar *l*, and the long ends supporting the weight of the ball by means of two screws, *g g*, passing through its sides and resting on them. The brass bar expanding more than the steel one by an accession of heat, drives down the short end of the lever and lifts the longer end, and, with it, the weight or bob of the pendulum. Adjustment is effected by screwing in or out the screws at the side of the ball, thus shortening or lengthening the effective end of the lever.

This construction has the same defect in action that the gridiron pendulum has. It moves by jerks, unless made with an extraordinary degree of precision, while the mercurial form is smooth and gradual in its movements.

Numerous other forms have been contrived, but as yet none have excelled the invention of Graham, to whose memory a deep debt of gratitude is owing by those who have benefited by the results of his labours.

We now conclude the subject of clocks, and in the next number we propose to enter upon the history of chronometers and pocket watches.

A NEW MODIFICATION OF THE REMONTOIRE PRINCIPLE FOR TURRET CLOCKS.

To the Editor of the Horological Journal.

Sir,—The variable force exerted on the escapement of turret clocks, caused by the action of the wind upon the hands &c., has long since been found objectionable, and the French clockmakers have very successfully overcome this difficulty by many ingenious arrangements of the *remontoire*. The Royal Exchange clock and several others manufactured by the late Mr. Dent are made on this plan, but the English clockmakers generally have not hitherto appeared inclined to adopt it; perhaps the following arrangement, which in some respects I think superior, may be worth their notice.

I consider that it would be an improvement in very large turret clocks, with four dials and four motions, to have a separate barrel, weight, and train, exclusively applied to the hands.

We already have a separate train, discharged every hour or quarter, to work the striking part.

By the plan I propose, we should have an additional train, discharged every 20, 30, or 60 seconds, whose duty would be to carry the hands and start the striking part. There are numerous methods of discharging this train with very little friction to the going part, as in the remontoire. Notches are cut through the scape-wheel arbor, and a long arm connected with a fly which terminates the motion train, is allowed to escape every 30 seconds,—the arm passing through 180° every time it escapes. The momentum of the fly will cause it to traverse more than 180°.

By this arrangement any additional power may be applied to the motion train without increased friction to the going part, by simply lengthening the arms connected with the fly, in the same ratio as power is added to the train,—bearing in mind that the pressure of the arm against the scape-wheel arbor is inversely as the square of the distance from the centre of the fly. Any one acquainted with the remontoire will understand the above description without a diagram.

However, these are matters of detail. The principle I suggest is, that the clock shall consist of three distinct trains:—

1st. The going train. This may be a dead-beat, or, better still, Mr. Denison's gravity escapement.

2d. The motion train.

3d. The striking train.

Although this plan is, virtually, a modification of the remontoire, yet it appears to me desirable that the three trains should be kept entirely separate and distinct, especially when the power required to work the motions is considerable.

I have hitherto addressed you under the *pseudonyme* of "Cornhill;" but, as I imagine that it may be preferable for your correspondents to be acquainted with each other, I have the honour to subscribe myself,

Your obedient servant,

R. Webster.

74, Cornhill, June 4, 1859.

The Clock at the Westminster Palace.—Yesterday (May 30) the clock in the Clock Tower of the Westminster Palace was set in motion, but the hands on two of the dials only told the time—viz., that facing the west and that facing the north. No hour was struck, nor were the quarters chimed. The cause why the hour and minute hands on the other dials did not go is stated to be, that the machinery by which they are turned is not of sufficient power to put all in motion, and that it will be therefore necessary to remove them, and to put up "hands" not so heavy. With respect to striking the hours and the quarters, it will be yet some time before the machinery can be attached to the bells fixed for that purpose.

Foreign Clocks and Watches.—The total number of foreign clocks imported into the United Kingdom in the four months ended the 30th April, 1859, was 82,900, and of watches, 34,832.

COMPLETE SPECIFICATIONS OF PATENTS. No. 3.

CHARLES HALEY.—Aug. 17, 1796.

A Description of CHARLES HALEY'S *New-invented Escapement for Marine and Pocket Timekeepers.*

The utility of this invention is to communicate to the balance an invariable and equal force notwithstanding the imperfections of the mainspring and train of wheels by which the motion is generally communicated; and this is effected in the most simple and perfect manner by means of an intermediate agent or spring with a new apparatus placed between the balance wheel and balance, which is wound up 150 times in a minute by the common movement; and as in a train of 9000 beats per hour there are also 150 beats per minute, just so often will the balance be impelled by the renovating spring: but this matter will be particularly described hereafter.

Figures 1 and 2 represent the principal parts of the movement that are more immediately connected with this new invention. The same letters of reference are put to both, so that in reading the description the eye may be directed from the one to the other.

A B is the pottance plate, and T the balance, the pivots of whose verge or axis, P X, are run into the cock C and pottance D. Above the balance T is fixed a pendulum spring, S, in the usual way, by pinning the upper end of the spring to a piece screwed upon the balance cock and the lower end of it to a piece which is twisted on the axis of the verge immediately above the balance. Below the balance and on the axis of the verge (which is a small solid cylinder) are placed two small steel collets, I and K. These collets turn stiffly on the axis of the verge, so as to be set in any position, and each has a ruby pallet fixed in the collet and standing a little way beyond their surfaces.

We call I the discharging pallet, and K the impelled one. It is therefore obvious, that if the balance be made to vibrate ever so little, the pendulum spring S and pallets I and K will vibrate to and fro along with it. E is the balance wheel, of the usual form, which is run just free of the upper surface of the pottance plate; its under pivot is run into a cock, F, screwed on the same side of the pottance plate, and its lower pivot into a cock G, screwed on the lower side of the same plate. W V is the axis of the new-invented renovating spring R and its apparatus. The axis is a small solid cylinder, and its upper pivot is let

into a cock H screwed on the pottance plate, and its lower pivot, V, into another cock, D, which is screwed on the under side of that plate. This axis is placed directly between the balance wheel and verge; consequently the axis of the balance or verge P X, the axis of the renovating spring W V, and balance wheel E, have their centres all placed in the same right line A B. (See *figure* 2.)

On the axis of the renovating spring, and in the same plane with the balance wheel E, is stopped the round steel pallet M; it is just so large as to turn round without touching the points of the teeth of the balance-wheel at No. 1 and 2 (see *figure* 2). There is a notch cut in this round pallet, so that the teeth of the wheel may be at liberty to act into it. The face or notch of the pallet is represented as having moved from a position pointing to the tip of the tooth 2 to 1, by the tooth 1 of the wheel acting into it. On the upper side, and close to this round pallet, is twisted a steel pallet, N, in form of a snail. This new contrivance may be called the snail pallet. There is a small dove-tail cut in this pallet near the centre, into which is fixed a small ruby pallet; it points directly to the face of the notch of the round pallet M, or to the tip of the tooth of the balance-wheel I. Above this snail pallet is twisted a collet O (see figure 1), to which the lower end of the helical renovating spring R is pinned, and the upper end is attached to a piece which is screwed upon the cock H near W. On the same axis of the renovating spring, but on the lower side of the pottance plate, is twisted the pallet L; it may be called the impelling pallet, because when the renovating spring is discharged it communicates that motion to the balance by striking upon the pallet K which is placed upon its arbor. It is necessary to observe, that the renovating spring with its collet O, the snail N with its small ruby pallet, the round pallet M, and impelling pallet L, being all attached to the same axis W V, will all move backward and forward together, with the same velocity, and keeping the same distance asunder.

In *figure* 2, *a* is a detent spring, fastened on the upper side of the pottance plate by a screw and steady pin, *n*. This spring points directly to the verge (that is, the centre of the verge), and approaches very near it. The breadth and height of it above the surface of the pottance plate is represented at *figure* 3, which is equal to the height of the discharging pallet I above that plate.

Upon the side of the spring *a*, next the balance wheel, is fastened a very tender spring *m*, by means of two pins near *a*. This spring projects a little way beyond the end of the other, and is therefore nearer to the centre of the verge. There is also fixed near the end of the stronger spring a ruby pallet, *r*.

The cock *b* is screwed upon the pottance, and the hole at *i* is taped to admit the thread of the adjusting screw *c*, its head being placed towards the centre of the snail, and the ruby *r* of the detent spring *a* is made to bank against the inside head of this adjusting screw, and bearing with a small degree of elasticity.

(This adjusting screw *c* is purposely put at some distance from its place and connected by a dotted line, because it would cover the small ruby pallet *r* and acting face of the snail, and thereby prevent their action from being seen.)

When the snail pallet N is brought from the balance wheel E towards the verge, the renovating spring is wound up; but when it moves from the position it has in *figure* 2 towards the balance wheel E, it is let down. When the renovating spring is wound up, the inclined or rounded-off part of the snail acting on the inclined part of the back of the ruby pallet *r*, and thereby pressing the detent spring *a* and ruby pallet outwards, or from the balance wheel until it passes over it, when the detent spring returning to its former place, the snail is prevented from returning, and therefore the renovating spring remains suspended in a state of tension. If the discharging pallet I or the axis of the verge is moved from its present position to the other side of the detent spring *a*, it will lift the delicate spring *m* until it pass on the other side of it, but without affecting the detent spring *a*, which is banked upon the head of the adjusting screw; but when the discharging pallet returns to its point of rest it will carry both springs with it; and when the ruby *r* is lifted beyond the reach of the snail, the renovating spring will be discharged and move with considerable velocity towards the balance wheel.

There is also placed on the other side of the balance wheel E another detent spring D, but without any other spring attached to it, nor does the pallet which lifts it ever pass on that side which is opposite to the wheel E; it is screwed on the upper surface of the pottance plate, and points directly to the centre of the axis of the snail, which it almost touches. The height of this detent spring above the surface of the plate is shewn in *figure* 4: *s* is a sapphire pallet which is set into it, and the tooth of the balance wheel 3 is represented as resting upon it; *y* is an adjusting screw which moves the detent spring *a* nearer or further from the verge, so that the teeth of the balance wheel 1 and 2 may be equally free of the round pallet M.

The balance wheel E moves in the direc-

tion of the arrow Z, and therefore will extend the spring *d* when locked upon it; *e* is a cock, and *f* an adjusting screw which is screwed into the end of the cock *e*, with its head towards the centre of the balance wheel E, on which the sapphire pallet *s* banks in the very same manner that the detent spring *a* banks upon the adjusting screw *c* already described; *g* is a small cock or stud, in which there is an adjusting screw to bank the detent spring *d* when it is lifted from the balance wheel outward. Let any force move the balance wheel in the direction of the arrow Z, then when the small ruby pallet near the centre of the snail facing the tip of the tooth 1 comes to strike the detent spring *d*, the sapphire pallet *s* will then be lifted beyond the tooth 3, so that the wheel may escape, but the face of the round pallet will be brought into a position pointing to the tooth 2, at that instant the balance wheel will strike on the face of the round pallet, and carry it back again to 1, when the snail will have passed beyond the ruby *r*, and thereby wind up the renovating spring.

Here it is plain that the force of the train must be sufficient to wind up the renovating spring; the strength of which may be increased or diminished at pleasure.

Having considered the action of the principal parts of the escapement separately, it now remains to describe the operation of the whole together. When the balance is at rest and the renovating spring wound up, the whole will appear ready for action, as in figure 2. We must also imagine the balance wheel to turn round in the direction of the dart Z, and that it is pressing against the sapphire *s* of the detent spring *d*, with a force equal to what remains of the mainspring after passing through a train of wheels; and we are further to suppose the force of the balance wheel, renovating spring, and weight of balance adjusted to one another. If in this situation the balance and its spring is made to vibrate, so that the discharging pallet I on its axis passes on the other side of the detent spring *a* by lifting the tender spring along with it until it drops, but when the discharging pallet returns it lifts both springs of the detent *a*, the ruby *r* being carried beyond the reach of the snail pallet, the renovating spring is discharged, and immediately the impelling pallet L fixed on its axis strikes on the pallet K of the axis of the verge, and carrying with it the balance with its pendulum spring until such time as the pallet L has carried the pallet K as far on the other side of the line A B which joins the centres and is just ready to quit it. During this *time* the round pallet, snail, and other *apparatus belonging to the* renovating spring are perfectly detached from the balance wheel, but presently after the two pallets K and L have left one another, the small ruby pallet near the centre of the snail has advanced to discharge the detent spring D, and the acting face or notch of the round pallet will point to the tooth 2, but the sapphire pallet *s* of the detent spring *d* being lifted beyond the reach of the tooth 3, the tooth 2 of the balance wheel drops on the face of the round pallet and returns it back to its former position and winds up the renovating spring. In the mean time the balance, from the impulse it has received, continues to vibrate above a semicircle, more or less at pleasure, from the point of rest. On returning back it will pass the point of rest and move the tender spring without meeting any obstacle in the way, for the impelling pallet L was at the same moment of renovating the spring shifted back to its proper place. The balance now returns back, discharges the renovating spring, which impels the balance, and is again renovated by the train, and thus the motion is continued.

Although we have made choice of a train of 9000 beats per hour, it is left to the discretion of the artist to fix upon a quicker or slower train. The timekeeper may be made to go 30 hours, 50 hours, or a week without winding. The renovating spring may be a spiral having all its coils in the same plane, or in the surface of a cone or cylinder, and may be made of steel, gold, platina, &c. And the principle of renovation may be applied several ways. Instead of the detents acting as springs, they may be made to move on pivots, and may be placed either above the pottance plate or below it.

CHAS. HALEY.

British Horological Institute.

THIRD LECTURE, June 7, 1859.

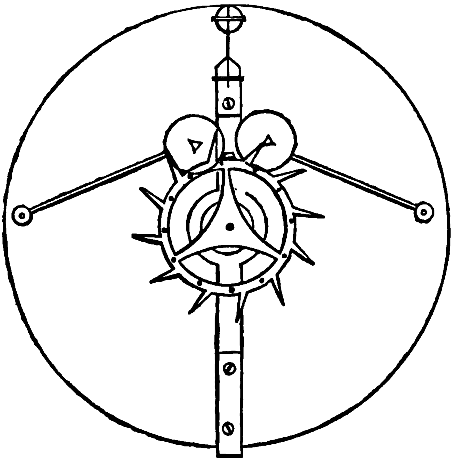
ON THE DETACHED LEVER ESCAPEMENT;

With Introductory Observations on the Principles and Construction of Chronometers, Pocket Watches, and other Timekeepers.

By MR. JAMES FERGUSON COLE.

In accordance with the wishes of the Council of the British Horological Institute, I have accepted their invitation to give a short Lecture, in the hope of being able to submit a few observations referring to the principles of timekeepers; but chiefly, in the present instance, with regard to chronometers and pocket-watches, as portable machines dependent for timekeeping effect on the vibratory motion of a balance governed by the elastic resistance of a balance spring, while clocks, as fixed machines, depend on the oscillatory motion of a pendulum governed by the principle of gravity. This latter class of timekeepers will more properly be a subject for future inquiry, though in the

ther with the impediment from thickened oil, and the effect of various temperature on a spring, render this delicate winding action so far doubtful, that I have long since given up the use of remontoire escapements. The latest example of the kind constructed by me was a remontoire gravity escapement to a clock publicly exhibited about fifteen years since, and to which the same objections applied. The plan and principle of this escapement is shown in the Diagram



No. 2. In this the escapement wheel has a double set of teeth or pins, resembling the duplex wheel, the long teeth rest alternately on lockings formed from the studs, which carry two moveable rollers; these answer the double purpose of preventing friction and the requirement of oil, and are also the weights which keep the pendulum in motion by their alternate gravitating action upon a fixed stud or smaller roller attached to the pendulum rod. In this arrangement the gravity rollers are carried by two slender arms, proceeding each from a centre of motion, by pivots or studs fixed in the plate of the clock frame. The action of this escapement is remarkably free, as the friction at the lockings and centres is only about one-tenth as much as in the ordinary Graham dead-beat escapement. Impulse power, of course, is uniform on the pendulum, and the locking resistance would be sufficiently equal from a high-numbered train of a weight clock. The objection to this is the uncertainty of locking from the momentum or fling of each roller, which is to be checked only by the addition of a secondary fly motion to govern the train.

The principle involved in all escapement mechanism in watches is in its general aspect of simply a mechanical character, and, viewed in this light, might appear only as a means of transmitting impulse power to the balance. Such, however, is not strictly the case, as any undue resistance, arising from defective application, or from a want of correctness in formation of the locking angles, &c., in whatever principle of escapement, is well known to affect both the mechanical result in motion produced, and also the isochronous result on time. It is therefore of the utmost importance that every point relating to principle, proportion, adaptation, equilibrium, and perfect liberty of all the acting parts constituting the mechanism of a timekeeper should be carefully made correct from the foundation upward before subjecting the instrument to trial, as any want of attention to such necessary particulars would materially interfere with the ultimate timekeeping result, and defeat the object sought. I may here observe, that, in reference to this subject, the opinions offered are dictated by the experience of many years earnestly devoted to theoretical and practical chronometer, watch, and clock making.

Reverting to the *lever escapement*, I will now proceed to make a few extracts from a manuscript paper, written at different periods, but drawn up in the present form and intended for publication in 1851. Some diagrams were at that time printed in illustration of this subject; and I now intend to publish these original papers by subscription, should I succeed in obtaining a sufficient number of subscribers. The paper contains observations on the detached lever principle and its application, with practical working rules for finding the proper relative proportions and places of the respective parts, including also some remarks on points of general construction and timekeeping principles of the watch. The opportunity this evening will only allow my selecting such portions of the paper as may convey to the present audience an idea of the views taken by me in treating the subject.

Extract from Horological Paper No. 1. — James Ferguson Cole on the Detached Lever Escapement.

The detached lever escapement, now generally adopted for ordinary pocket watches, is ascribed to Mudge as its inventor. It is evident, however, that the first or rudimentary portion of this escapement is strictly that of Graham's pendulum clock, the crutch being made to act upon and give impulse to a free vibratory balance instead of a pendulum; the crutch, therefore, is a lever, and by a peculiar formation of the impulse end is made by Mudge to act alternately on a double kind of pallet, or rather two distinct pallets, both being fixed upon the balance axis in different planes, with also a third piece as a detaining roller for safety of the action, as shown by the original plan described in Mudge's Treatise and other works upon the subject. Graham's escapement for clocks, commonly known as the *dead-beat* escapement, is frictional through the entire arc of vibration of the pendulum during and after impulse on either side; the distinct feature of improvement in the plan of Mudge consists in the perfect liberty or detachment of the vibratory balance immediately after receiving the lever impulse, and hence the term "detached lever." The original plan of Mudge, like most other inventions in the early stage, though complete as a principle, admitted of much simplification and improvement in details of construction and in the relative proportions of the acting parts, in order to produce the desired mechanical effect; upon the proprieties of which, in a certain measure, will depend the regularity and permanence of the timekeeping; as, notwithstanding the natural perfection of the balance and balance spring as primary principles of gravitating and elastic force when acting independently of any other force or impediment, they will, if interfered with by any circumstance, be subject to a deterioration of the natural property of the principle or force in question. Under the general term "impedimental resistances" may be understood those arising from pressure of the atmosphere, friction from gravitation of the matter in motion, together with friction arising from motive force through the train of wheel work, glutinous oil, &c.

The chief object here in view being to explain and illustrate in a concise and intelligible manner the true principles of the detached lever escapement, I shall offer only a few remarks on the various modifications of this class of principle, of which the well-known and heretofore extensively used *rack lever* escapement may be mentioned; the origin of which, though doubtful, appears traceable to the old escapement by Dr. Hook, or Huygens, as recorded in the fourth edition of Dr. Derham's "Artificial Clock Maker," where, upon the vertical old verge, on which the balance is usually fixed, is placed a common-toothed wheel, driving a pinion as the balance axis alternately forward and backward, wanting only the Graham dead-beat wheel and pallets to complete the

rack-lever principle. As regards the detached lever by Mudge, it may be admitted that the present generally adopted plan for the lever action on the balance by a cylindrical round ruby pin fixed perpendicularly through the horizontal face of a small disc of steel, technically called the "roller," though having no property of rolling, and commonly known by the term "table roller," must be regarded as a valuable improvement for its greater simplicity and ease of execution, and as effecting the important object of detachment of the balance. A further improvement with good effect was by flatting away just one-third of the outer side of the above-named cylindrical ruby pin. The value of this apparently little alteration, well understood by watchmakers, may be stated to consist in allowing a contraction of the lever motion from side to side, with a proportionately reduced friction and labour on the lockings, and, as a consequence, less retardation of time in the short arcs of the balance vibrations, by admitting a closer banking of the lever. This advantage is now seldom neglected in the manufacture of ordinary detached lever watches. There are various other modes of the lever and roller action, having no advantage over the common table roller action with flatted ruby pin when properly made. Even a perfect principle, particularly one of so much delicacy, loses its efficiency by any neglect or want of attention to the smallest details of manipulation or final adjustment; yet, notwithstanding the delicacy of so minute a mechanism as that of a small pocket watch, a right principle properly carried out seldom fails to perform satisfactorily, as evidenced by the widely extended manufacture of the timekeeper in its various forms.

Before entering upon the chief subject of inquiry in this paper, I would be understood as not intending to offer any rigid rule or process for the attainment of an end which practical watchmakers already arrive at by their own peculiar modes, established by custom and experience. What I here propose is a reduction of the proportions of the mechanical parts of the detached lever escapement to a rule, which, if correctly observed and adopted, may lessen or prevent the liability to failure in the ultimate mechanical and timekeeping results, when made by workmen of less mature experience.

The first consideration, before proceeding to determine what shall be the relation and place of the several parts of the escapement, is to determine what shall be the proper *diameter and weight of the balance* for the proposed watch movement. This, I need not say to the scientific watchmaker, is only to be ascertained in the first instance by mechanical trial, and by the result in motion produced. Upon this question of diameter and weight, which has engaged much of my attention, a lengthened inquiry may be gone into, which, requiring details of experimental trials and results, will more properly be the subject of a distinct paper. That the weight should bear some preferable relation to the diameter cannot be doubted, as either carried to an extreme must destroy the harmony of proportion. In practice it is well known that these relations are not of an arbitrary nature, as some latitude on this point is found to be admissible, there being no law of the balance or rule of proportion between weight and diameter that will stand the same under varied distribution of the matter of the balance, and also the varied speed of the train. It will therefore be sufficient for the present purpose to state only that a balance of any diameter and any weight kept in motion by a power sufficient for producing any definite amount of vibratory motion of the balance—say, for a lever watch, a turn and a half at least—and going to time, will, if the weight be increased, and the diameter reduced again to time with the same balance spring, be more susceptible of motion than before from casual irregularities of motive force, or from influence of external motion, as in riding, and will also exhibit a greater disparity of motion by change of position from end to side bearings of the pivots, as in the hanging and lying positions of the watch. The contrary of these effects will arise from a diminished weight and enlarged diameter, with also an increased resistance from atmospheric pressure; but this last effect will be in a less proportion, as the amount of matter and surface is less by the diminished weight. In estimating the comparative value of these relations, under varied proportions of weight and diameter, the mean effect of the motive force, by the motion produced in the hanging and lying positions together, must be taken in each case respectively, in order to arrive at a satisfactory conclusion. In fusee lever movements of the ordinary half or three-quarter plate construction, a balance only of a limited diameter can be admitted for want of room. The diameter in a well-constructed movement of this kind may properly be that of the barrel for a medium train of 16,200 vibrations per hour, or four and a half vibrations per second. The diameter being thus fixed, the proper weight can only be known by the mechanical effect of the power in producing motion at the balance. This effect of the power will also, to some small extent, when going to time, depend on the speed of the train, that is, on the relative number of vibrations or beats per second; every vibration in the lever watch being a beat, while in the chronometer and duplex escapements every two vibrations make a beat or impulse from the motive power. Upon the speed of the train, whether calculated by the relative numbers of the fourth wheel and scape-pinion for producing four, five, or six vibrations per second, or any intermediate fraction of those numbers, will depend the strength of the balance spring. The number or strength of wire for such spring, therefore, can only in a first instance be guessed at. This may be done very nearly by the judgment of an experienced watchmaker. But when the spring is applied, and the watch brought to time, should the balance vibration upon the pivot end much exceed one turn and a half, the balance will be required heavier, if the mainspring be not too strong; but if the vibration on the pivot end be much less than a turn and a half, with the strength of mainspring and all other conditions right, the balance will be required lighter; and in both cases the balance spring will have to be respectively stronger or weaker to bring the watch again to time. These are the only means by which the proper weight for the given diameter of balance, and also the proper strength of the balance spring for producing exact time, can at first be found. The results of this process will, therefore, be data for calculating what shall be the proper diameter and weight of balance and strength of balance spring for a quicker or slower train in other lever movements of the same size, height of pillar, and consequently of the same power, economizing by such calculation and memoranda the time, trouble, and expense of repeated alterations, as shown in this experimental first instance, the result arising being wholly beyond the power of figures to determine mathematically. The mechanical data are the basis on which all calculations upon this subject must depend. For a first movement of any other size, the preceding experimental trials, and consequent alterations, will of course be unavoidable. In watch manufacturing it is the business of the manufacturer to supply to the escapement maker the movement with the balance of proper diameter and weight. The diameter being assumed for the present purpose to be that of the barrel, I establish a working rule of proportions, by taking the barrel or balance, which is the same, as a standard of measure, as will be shown in my intended publication.

The barrel or balance as a standard involves no principle, and is only adopted for the purpose of

making the wheel and other parts of the escapement of consistent dimensions. The points of principle to which I have given attention more especially are the adaptation of such angles and proportions throughout the escapement action as will diminish locking and other resistance, and thereby improve the mechanical and ultimate timekeeping effect. Whether for large or small movements, the balance diameter and weight must be supposed properly determined.

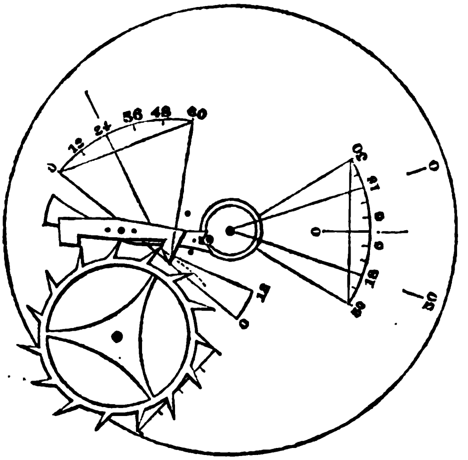


Diagram No. 3 is a long arc escapement, having 12 degrees of motion at the pallets and lever, and 36 degrees as the impulse arc at the roller and balance. An example of the long arc is given, to show the difference between the long and short arc proportions and the difference of effect produced. In this figure the driving-plane of the first pallet for producing 12 degrees motion of the pallets is a line direct to the delivery point of the second pallet, it being impossible to produce that amount of motion by any smaller angle, though it may be done improperly by pitching the escapement too deep. For 10 degrees motion of the pallets, the first pallet plane of impulse will be a line direct to the angular point of locking on the second pallet. For 8 degrees of motion of the pallets, the line of the first pallet plane of impulse will be direct to the inner corner formed by the breast and locking face of the second pallet, the length of the locking face being made equal to the impulse plane. Those directions of the impulse plane of the first pallet n the preceding cases refer only to pallets adapted to 15-toothed wheels, as when the number is higher with pallets scaping over four teeth, a greater angularity will be required on the impulse planes for making the same number of degrees of pallet motion. I have been thus particular, as the bearing of those pallet face lines of direction is a ready and sufficiently correct rule for determining any required arc of motion for the pallets, half a degree more or less being of no material consequence. The only apparent reason for preferring the use of long arc pallets is, that the greater motion of the lever and consequent stronger intersection of the curves ensures greater soundness of the detaining principle in connection with the common table-roller, which, being more simple and easy to make, is most generally adopted. The full diameter of this roller exceeding the radius of the ruby pin also allows the lever banking against the roller edge to be effected by a simple upright guard-pin projecting from the flat surface of the lever; the pallets attached having only a limited action, are necessarily checked by banking the lever against two pins inserted in the pillar-plate, though it is sometimes done by one pin and a fork-formed tail to the lever.

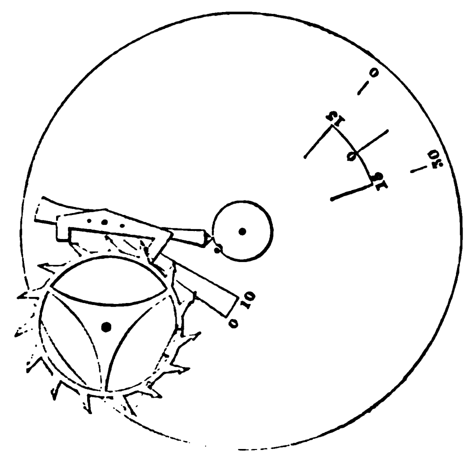
On the proper adaptation of those banking-pins the correctness of the lever principle materially depends Many instances of defective application in this apparently simple department have fallen under my observation, which, together with the liability of rightly-applied pins being accidentally bent, and the freedom and lockings thereby disturbed, I have been induced to adopt an alteration in the mode of banking, by which those objections are wholly removed, and the time usually occupied in making the escapement considerably reduced. In this improved mode of banking, as in the former banking on the frame, there is a secondary action, technically called the "draw." This arises out of a very slight deviation of the locking-faces of the pallets from the true circular form at the place of rest. If these faces were truly concentric curves from the centre of motion of the pallets, the effect would be a dead rest of the wheel-tooth, producing no motion of the pallets in either direction by pressure of the wheel; but as it is of the greatest importance to the uniform timekeeping property of this escapement that no uncertainty of freedom should occur between the guard-pin in the lever and the roller edge, that evil is provided against in the detached lever principle by forming the locking-face at an angle so small as only to produce a slight tendency of the pallet inward by the wheel pressure at those points. This constitutes the draw, or supplementary arc; and any greater angularity of the locking-faces than is sufficient for retaining the lever with soundness against the frame banking will be detrimental, as an excess of angularity on these faces would cause the escapement to set on the lockings.

I may here remark, that the disadvantage arising from drop at the fork and roller action, and also from side-shake of pivots, is much reduced by blunting the locking edges of the pallets.

In short, the perfection of the detached lever principle depends on right proportions, close action, shallow but sound lockings, with perfect freedom and smoothness of finish in every place of action; the motive power and resistances being so adapted as just to prevent setting on the impulse, or very little more, and thereby to produce not less than a turn and a half of vibratory motion in any case, however much the impulse arc at the roller and balance may be reduced—say, to 30 or 28 degrees; and therefore it will be of doubtless advantage also to adapt the motive force to the diminished arc of impulse, so as it will thereby be multiplied a greater number of times in the ultimate arc of a turn and a half of vibration. On this, according to my own view, and with the judgment of other experienced watchmakers, depends the most important property of mechanical timekeeping. By a turn and a half of vibration the impulse arc of 36 degrees is multiplied 15 times, and by 30 degrees 18 times. The impulse arc thus reduced allows the balance to acquire a higher velocity at the point of unlocking, which duty interfering less with the pure vibration is less likely to affect the isochronism, the locking resistance being a mechanical element of isochronous defect.

Referring again to the escapement, I do not recommend using the common table-roller with pallets of less than 10 degrees arc of motion from drop to drop of the wheel, with a three and one lever and roller, making 30 degrees at the balance, as shown in Diagram No. 4, as in order to make the roller banking safe at a less arc, the pallets will require being allowed to draw more into the wheel when locked. With pallets of 10 degrees, and a three and one lever, the table-roller will admit being made to detain the lever quite safe.

Experience, however, confirms the propriety and advantage of a shorter arc of impulse than 36 degrees at the roller and balance, as the acknowledged basis of a steady and permanent timekeeping principle consists in the "higher detachment;" and therefore that



escapement, of whatever construction, which offers least resistance in unlocking, and from this or any other cause allows the motive force to produce the greatest amount of vibratory motion of the balance, is, undoubtedly, best calculated to realize those very desirable and important results. The above considerations show the consistency of a reduction in the arc of impulse at the balance. This should be done, not by enlarging the diameter or radius of the impulse-roller or ruby-pin, as it improperly may be done, but rather by reducing the motion of the pallets, by reduction of the angles of the driving planes from an acute to a more obtuse form. By this alteration of the angles from 12 to 10 degrees, the power of the wheel will impel the pallets with greater determination and brevity of impulse. Such pallets will suffer less retardation from thickening of the oil, and further, by reduction of the radius of the impulse pallet or ruby-pin, the labour in unlocking will be proportionately less.

Another point of principle in the lever escapement requiring particular attention is the number of teeth scaped over or embraced within the pallets. This should be governed by the former argument, that it is desirable not to increase the locking resistance, which will be least when made to scape over the smallest number; therefore three teeth of the wheel, as represented in all the diagrams, according with the common plan in general use, is theoretically preferable to four or any higher number of teeth within the pallets, whatever may be the number of the wheel. In practice, pallets scaping over four teeth are found to answer quite well with a wheel of not less than 18 or 20 teeth; and though an objection lies against the greater resistance at the lockings, some advantage is gained in power by the increased length of the pallet arms, producing at the same time a shorter arc of pallet motion and more equality in the two drives.

In the original formation or adaptation of pallets to either the ratchet-toothed wheel or the club-toothed wheel, for any specific arc of pallet motion desired, a further and more rudimentary principle for determining the angle and consequent arc of motion than that already given by the line of direction of the first pallet-impulse plane, is derived from the following fact, which relates correctly only to 15-toothed wheels:—On comparing the respective values of the various pallet-impulse angles, it appears as a coincident result that if a base line be drawn from the delivery point of the second pallet direct through the centre of motion, and another line from the same delivery point be drawn direct to some other point outside the centre of motion, that the number of degrees contained between those two lines, of any required extent (and which I call the "angle of divergency,") will be in all cases *exactly double the number of degrees contained in the scaping arc of the pallets*, including the two degrees supplementary arc of the lockings, from drop to drop of the wheel, as shown in Diagram No. 3.

Returning to the general subject, the *lever* principle of escapement differs from the *chronometer* in not having to move over the supplementary arc before unlocking the wheel. The chronometer when at rest being locked, requires some auxiliary force by external motion or agitation of the whole machine to set it going, while the lever escapement when at rest is always unlocked, and, if properly made to right proportion, will start into motion by the power from the escape-wheel, which at the quiescent point of the balance is pressing on one or other of the pallet planes of impulse. The lever principle, therefore, notwithstanding the diagonal drive and consequent greater friction during the impulse, is better adapted for portable timekeepers and pocket watches than any other principle at present in general use. On the other hand, the many points from which a wrong effect may arise is evident, in my own experience, from the frequent alterations required in new work, and the extent of explanation necessary in this description. The principle of this escapement, however, is such that, with an excess of power, it will perform well under some defects of proportion, as a large arc, and some faults of adaptation, but of course with corresponding mechanical disadvantage; and for this reason chiefly it has become so generally practicable and universally adopted.

I now proceed to give a description of what I have long considered to be a desideratum and very necessary improvement in the construction of all portable timekeepers, particularly those intended for ordinary pocket use, as not one of the many escapement principles hitherto adopted or published has been described as possessing the desirable property of resisting the detrimental influence on timekeeping of external motion of the watch, as pocket watches, of whatever construction heretofore in use, are constantly liable to considerable disturbance of their otherwise correct performance by any external agitation of the entire machine producing excess of motion in the balance, as in riding. Chronometers and duplex watches are generally constructed without bankings, and in this condition, if subjected to any circular motion in the plane of the balance, will be liable to repeat the escapement impulse and gain excessively; ordinary lever watches, on the contrary, have bankings, as a necessary consequence of construction, and, though they cannot overrun, are liable to great acceleration on time from reaction of the balance against the lever bankings, which also subjects the escapement to serious injury. A remedy for these objections in chronometers and duplex watches was found in my construction of *double-rotary non-repetition* escapements by various modes, which I may more fully describe at a future opportunity. The banking error of lever watches, after a great variety of experiments, I first effected by a flexible lever arm, and afterwards by single and double banking springs and single and double passing springs in various modes of application; but the error was finally remedied by me in a more simple manner, by an original principle of double recoil lockings, designated the *Resilient Lever*.

Two modes of this principle were published in the *Revue Chronometrique* for January, 1857, and in the *Mechanics' Magazine*, Oct. 2, 1858; and a third mode, in addition to these, in my Provisional Specification of an intended Patent, March 6, 1858. The improvements consist in a simplification of the principle and work by omitting the use of banking pins, the banking being made not upon the lever, but upon the locking extremities of the pallets, in the following manner:—In the first instance, the common ratchet-toothed wheel was put reversely on its pinion, so that

the sloped backs of the teeth moved in the driving direction, the wheel having been passed through a small machine tool, by which the locking points of the teeth were bent outward, at an angle sufficient for the depth of locking; the former back of each tooth was then the locking face so far as the bend, and the locking corner of each pallet, in descending into the wheel, rested alternately on the root portion of each tooth thus inclined forward; the abutment of each pallet on these slopes rendered the pallet banking complete. By this mode of banking on the wheel the lever fork is required to terminate as a pair of thin edges, separated by a narrow notch, adapted to a small flatted steel impulse pin fixed in the roller or in the balance arm. This completed the resilient principle of action, which needs no guard pin or roller if the wheel and pallet action is properly made; but the guard pin and roller may be used at discretion, and when complete the effect produced is the prevention of all liability to injury, or acceleration on time, from external motion of the watch, with various points of convenience and working advantage. In Diagram No. 4 the double recoil is effected by a club-toothed wheel, cut to represent the bent-tooth wheel, with the addition of a short angle at the extremity of each tooth. The same effect arises if the additional angle is made on the pallets, adapted to the ordinary ratchet-toothed wheels, or common club-toothed wheels; and I may add, that all the various modes of this action I have found to answer well, and can only give a preference to the simplest form of the principle.

NOTE.—In reference to the Diagram No. 2. of the Remontoire Gravity Escapement, it will readily be seen that the present arrangement and principle admit of modification, inasmuch as the wheel may be of any number from three to thirty or more teeth, and that the centres of motion of the roller arms may be variously disposed, or inverted to a position nearly agreeing with the centre of suspension or centre of motion of the pendulum, in which case there will be no friction at the centre of the rollers. In the Diagram No. 2 the present diagonal action of the rollers on the pendulum induces a slight motion of the rollers, both in unlocking the power and in giving impulse to the pendulum, but the amount of friction induced is too little for serious objection.—J. F. C.

TO CORRESPONDENTS.

GNOMON shall appear in our next number

DECLINATIONS of the following STARS, and Times at which they are on the Meridian at Greenwich, for July, 1859.

Name of Star.	Day of Mon	Dec. North	Greenwich Mean Time of passing the Meridian.
		° ′ ″	h. m. s.
α Ophiuchi	10	12 39 52·2	10 15 14·06 P.M
	20	12 39 53·9	9 35 54·92 „
	30	12 39 55·5	8 56 35·75 „
α Lyræ (*Vega*)	10	38 38 76·4	11 18 49·89 P.M
	20	38 38 79·3	10 39 30·77 „
	30	38 38 82·0	10 0 12·13 „
α Aquilæ (*Altair*)	11	8 29 58·6	0 30 22·79 A.M
	20	8 29 60·6	11 51 3·77 P.M
	30	8 29 62·4	11 11 44·72 „

EQUATION OF TIME TABLE
For JULY, 1859.

Day of the Week	Day of Mnth	At Apparent Noon. Equation of Time to be *added* to Apparent Time.		Difference for One Hour.	At Mean Noon. Equation of Time to be *subtracted* from Mean Time.	
		m.	s.	s.	m.	s.
Fri. ..	1	3	24·88	0·486	3	24·85
Sat. ..	2	3	36·55	0·475	3	36·52
Sun. ..	3	3	47·94	0·462	3	47·91
Mon...	4	3	59·02	0·448	3	58·99
Tues..	5	4	9·79	0·434	4	9·76
Wed ..	6	4	20·21	0·419	4	20·18
Thurs.	7	4	30·26	0·402	4	30·23
Fri. ..	8	4	39·92	0·385	4	39·89
Sat. ..	9	4	49·17	0·368	4	49·14
Sun. ..	10	4	58·01	0·350	4	57·98
Mon...	11	5	6·41	0·331	5	6·38
Tues..	12	5	14·36	0·312	5	14·33
Wed ..	13	5	21·85	0·292	5	21·82
Thurs.	14	5	28·85	0·272	5	28·83
Fri. ..	15	5	35·38	0·252	5	35·36
Sat. ..	16	5	41·43	0·231	5	41·41
Sun. ..	17	5	46·96	0·209	5	46·94
Mon...	18	5	51·98	0·188	5	51·96
Tues..	19	5	56·49	0·166	5	56·47
Wed ..	20	6	0·47	0·144	6	0·46
Thurs.	21	6	3·93	0·121	6	3·92
Fri. ..	22	6	6·84	0 098	6	6·83
Sat. ..	23	6	9·20	0·075	6	9·19
Sun. ..	24	6	11·00	0·051	6	11·00
Mon...	25	6	12·25	0·028	6	12·25
Tues..	26	6	12·92	0·004	6	12·92
Wed ..	27	6	13·01	0·020	6	13·01
Thurs.	28	6	12·52	0·045	6	12·53
Fri. ..	29	6	11·43	0·070	6	11·44
Sat. ..	30	6	9·74	0·095	6	9·75
Sun. ..	31	6	7·44	0·121	6	7·45

TO ADVERTISERS.

As a Special Paper, published monthly and intended to become a work of reference, THE HOROLOGICAL JOURNAL will be found to possess advantages to the Chronometer, Watch and Clock-making Community unrivalled for cheapness and efficiency.

N.B. All Advertisements to be inserted in the Journal must be received before the 25th of the month.

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WHAT IS HOROLOGY?

(Continued from page 147.)

The History of Chronometers and Pocket Watches.

The department of horology upon the history of which we now enter is probably the most important of the whole. While those progressive improvements in machines for timekeeping at which we have rapidly glanced laid a solid foundation for the superstructure, it is in chronometry and its applications that we find the climax of perfection attained. It must, however, be borne in mind by all, that this perfection is but comparative. There still exist sources of error and uncertainty which require the closest scrutiny and the nicest workmanship to overcome, while there are others innate in the principles of the mechanism employed which can only be eliminated by further improvements. While great accuracy of workmanship and care in adjustment are generally rewarded with success in excellence of time keeping, there are yet faults which baffle the most skilful and can be only, even approximately, removed by a lengthened series of experimental trials. Hence the necessity for further efforts to improve, and that not merely from the mere mercenary motive of gain to the improver.

No good can possibly result to any one from the dogma, that enough has been accomplished, and that we need seek no further for improvement, but remain satisfied with our present attainments. Had our forerunners reasoned thus, horology would not have taken its present rank; had *we* reasoned thus, the Horological Journal would not have existed.

The term "chronometer" is compounded of two Greek words, signifying "time" and "a measure," and means literally a *time-measurer*. Under this designation we might include all kinds of timekeepers; but the term is generally used for those instruments especially constructed with a view to great accuracy, such as marine timepieces, employed for the purpose of ascertaining the longitude, and consequently the position on the ocean of the ships which carry them.

These timekeepers, being necessarily constructed so as to perform accurately notwithstanding external motion, possess many features in common with pocket watches, and therefore the history of both runs pretty much in the same channel; improvements in the one class being speedily adopted in the other, and, in fact, the object often being to construct chronometers of a sufficiently small size to be worn about the person.

For the sake of completeness it may be desirable to say a word or two with respect to the uses of marine chronometers.

The surface of the globe is crossed by a number of imaginary lines, at an equal distance from and at right angles to each other, called the lines of "latitude" and "longitude." The lines of longitude are longitudinal, or parallel to the pole or axis of the earth; and the lines of latitude are at right angles to them, or parallel to the equator. The lines of latitude are numbered north and south of the equator as a starting point, and the longitudinal lines are numbered east and west from some fixed point—generally the Greenwich Observatory by ships sailing from England or using English charts. Now it will be clear, that if we can find our distance from the nearest lines of latitude and longitude, and can find the numbers of these lines, we can then, by drawing them upon a properly constructed chart, ascertain very exactly our precise position on the surface of the earth. The latitude is got at by simply measuring the altitude above the horizon of any heavenly bodies which we may be able to observe with the proper instruments, and then reducing our observations by means of the proper tables. Longitude, however, cannot be so ascertained, owing to the rotation of the earth upon its axis, and the consequent apparent change of place of the stars. The only way at getting at it astronomically is by the method of lunar distances, that is, the apparent distance of the Moon from certain fixed stars, which varies in different parts of the earth's surface and at different hours. The moon is nearer the earth than the stars, and consequently appears to occupy a different position with regard to them at the same instant of time as we vary our station on the surface of the globe. Voluminous tables, and as voluminous calculations, are necessary to reduce the elements afforded by the observations obtained; and an additional disadvantage in using the lunar method in finding the longitude exists in the fact that the moon is not always visible. Now, difference in longitude is nothing more nor less than difference in time. All places on the earth's surface to the eastward of other places pass the sun's meridian, or the meridian of any star, sooner than those to their west, in the proportion of four minutes to every degree of longitudinal distance. If, therefore, we can ascertain at any moment the time at the place whence we have started and also the time where we are, the difference between the two reduced will give us the distance between those two points, and consequently our longitude. We get the time

for our own position by observation of the sun or stars, and our chronometers tell us the time at Greenwich.

The proposition to ascertain the longitude at sea by the aid of a timekeeper was first made in 1530, by Gemma Frisius. A marine pendulum clock was made by Hooke, and tried by Lord Kincardine, in 1662; and Huyghens also made one, which was tested at sea by Major Holmes, in 1614.

The subject was of so highly important a nature in connection with navigation that it soon attracted the attention of various governments and scientific bodies; and in the year 1720, and subsequently in 1747, the Academy of Sciences of Paris offered rewards "for the best method of finding the hour at sea." Massey and Bernouilly gained these prizes by essays on the subject.

In more general terms the British government had, in 1714, offered a reward of £10,000 for any method of determining the longitude within the accuracy of one degree, of £15,000 within the limit of 40 geographical miles, and of £20,000 within the limit of 30 miles, provided such method should be available more than 80 miles from the coast. This offer was the result of the labours of a committee, of which Sir Isaac Newton was one. Subsequent acts of parliament modified these offers, and many inventors tempted by the rich prize essayed to gain it.

We have seen how the variation of temperature would affect an ordinary pendulum, by altering its length, and therefore the time of its vibration. Now, although the difficulty about the pendulum was soon got over by the substitute of an equally weighted balance and pendulum spring in marine timekeepers, it was yet found that if the pendulum showed a marked difference of rate in various temperatures, the balance and spring was still more affected. We have, in fact, a far more delicate instrument, and one much more easily affected. An uncompensated watch is, in fact, a metallic thermometer; and it would be quite possible to ascertain the degree of temperature by its altered rate of going. The chief source of error is not the alteration of the proportions of the balance, but the effect of temperature in relaxing and stiffening the delicate balance spring.

Harrison, after long labour, in 1736, completed a marine chronometer which seemed to fulfil the requirements of the case. This timekeeper was first placed on board a ship of war going to Lisbon, the captain of which attested that Harrison had corrected an error of about a degree and a half upon his return to the English Channel. In 1739 he produced one upon a smaller scale, which, from experiments made, promised to give the longitude with even greater accuracy. In 1741 he finished another, smaller than either, which appeared to the members of the Royal Society more simple, and less likely to be deranged; and in 1749 he received the gold medal which was annually awarded by the Royal Society to the most useful discovery.

Having improved and corrected this third chronometer, Harrison applied to the Commissioners of the Board of Longitude in order to obtain a trial according to the Act of Parliament. This, after much delay, was granted, and his son was allowed to take a voyage to Jamaica instead of himself. William Harrison embarked at Portsmouth on the 15th Nov., 1761. After 18 days navigation the vessel was supposed to be in 13° 50′ west of Portsmouth by ordinary calculations, but the watch marked 15° 19′, and was at once condemned as useless. Harrison, however, maintained that if a certain island were correctly marked on the chart it would be seen on the following day; and in this he persisted so strongly that the captain was induced to continue in the same course, and accordingly the island was discovered the next day at seven o'clock. In like manner Harrison was enabled by his watch to announce all the islands in the order in which they would fall in with them. When he arrived at Port Royal, after a voyage of 81 days, the chronometer was found to be about nine seconds slow; and finally, on his return to Portsmouth, after a voyage of five months, it had kept time within about one minute five seconds, which gives an error of about 18 miles. This was much within the limits of the thirty miles prescribed by the act of 1714; yet, several objections being raised (chiefly, it is supposed, by Dr. Maskelyne, the Astronomer Royal, who gave preference to lunar observations), William Harrison was obliged to undertake a second voyage, the proof from the first not being considered sufficient. He embarked again on the 28th March, 1764, arrived at Barbadoes on the 13th of May, and returned to England on the 18th of September. This last voyage left no further doubt of Harrison's claim to the promised recompense, his chronometer having determined the position of Barbadoes within the limits prescribed by the act. £10,000 of the amount was accordingly paid, and the remainder was promised when he had sufficiently explained the principle upon which his chronometers were constructed to Maskelyne, Ludlam, Mudge, and several other eminent men appointed by the Board for the purpose. Considerable delay, however, occurred before the last instalment was paid. Liberal though the reward appears, it must be

remembered that Harrison employed his extraordinary talents on the subject for forty years before he accomplished his object.

The principle of Harrison's escapement was what is called a remontoire, or re-winder; a construction in which the prime mover is employed through the wheel-work in winding up a delicate spring which acts more immediately either on the escapement wheel or upon the balance staff. His method of effecting an adjustment for temperature was by a contrivance known as a compensation curb. The chronometer which won the prize is, we believe, still preserved at the Greenwich Observatory, although it can be seen by few in that necessarily secluded establishment.

A literal copy of Harrison's description of his timekeeper, with accompanying engravings, has already appeared in this Journal.

(To be continued.)

A FEW WORDS IN DEFENCE OF

ENGLISH WATCH-WORK.

By a Mechanic.

(Continued from page 104.)

It will now be perceived, that if the spring were perfect, and if consequently every vibration were absolutely equal-timed, the performance of the piece would be perfect, whatever the quality of the other parts of the machinery. Up to the present, however, such has not been found to be the case; for, notwithstanding that it has been demonstrated (on paper) that a spring of a spherical form should be perfectly isochronous whatever be its length, that form of spring has never been extensively employed; because it was found that the cylindrical form was very capable of adjustment to great nicety, was more easily fabricated than any other, and, moreover, possesses the property of adaptability in the marine department beyond every other. It must be remembered that special departures from perfect isochronism are necessary to counterbalance certain mechanical defects—namely, the disturbing effect of the maintaining impulse, the varying friction of pivots, and the effect of thickening oil under various temperatures, if we would properly estimate the value of a particular form of spring as compared with any other.

It is in the study of the properties of the *pendulum* spring that English chronometer makers have so greatly distinguished themselves; for they seem instinctively to have concluded, that here was to be found the portion of the machine whose development would reward them with success. Accordingly they tested every form—flat, cylindrical, conical, straight, and tapering; and it is to their studies that we are indebted for the knowledge of the two methods of adjustment, viz., that by length, and that by figure; and it is to them the world has yet to look for some written work that shall perpetuate the knowledge they have so laboriously acquired.

Although the idea had already been acted upon, of improving the machine by equalizing the irregularities of the first mover, it was yet perceived that a train of wheels, however nicely executed, transmitted force with considerable irregularity; and therefore ingenious mechanics set themselves to work to contrive a remedy at the *end of the train*, justly conceiving that the irregular impulse was at that point complicated by the force absorbed by unlocking the escapement,—a duty the balance has always to perform. The endeavour to get rid of this potent disturber has prompted the greatest variety of special inventions, under the title *remontoire*, or re-winder of a part of the body of the clock, chronometer, or watch.

The *remontoire* may be described as a contrivance for the purpose of interposing a *governor* between the force given out by the train of wheels and the part which finally gives impulse to the balance, whose capacity for storing force should be constant and determinable—say, a spring bent up a certain constant quantity, or a weight falling a certain constant distance. The most common form of this governor or remontoire being a double escapement, with the governing portion between them (spring or weight), being bent up or lifted by the first, and actuating by its tension or fall the second.

The remontoire principle is employed occasionally in clocks, but is otherwise quite abandoned; for it has always been found such a waster of the force employed to drive the machine, that the residue becomes too small and delicate to yield good results in the portable departments of the art. Excellent examples are, however, to be found amongst the contrivances of English watchmakers, as far back even as the vertical escapement.

As might have been anticipated, early in the modern history of horology it appeared evident that temperature must play a leading part in the requirements of good timekeepers, on account of the nearly universal expansion of bodies by access of heat and contraction by cold; and as the time of a pendulum is determined by its length, and that of a balance by the length and stiffness of the spring, which plays the part of gravity in a portable machine, any rise or fall of temperature would

necessarily alter the time of either pendulum or balance. This will the more readily be acknowledged when the fact is stated, that the ordinary difference between the temperature in England during summer and winter is equivalent to six seconds per day in a seconds' pendulum with an iron rod. In the clock the difficulty was soon got over by arranging metals showing great differences in their rate of expansion under a given increase of temperature so as to counteract each other; examples of which are the gridiron pendulum and the mercurial pendulum, both invented by Englishmen, and both so excellent as to leave little to be desired.

The *gridiron pendulum* takes its name from its form resembling a gridiron; being formed of nine parallel rods, five being made of steel and four of brass, the total length of each sort representing the ratio of their expansibility—namely, 100 to 60 or thereabouts, and so arranged by attachment to cross pieces that (acting in pairs) all the more expansible metal elongates upward and all the least expansible downwards, the centre rod (steel) having the weight or bob of the pendulum suspended to its lower end. The form of the material may be varied considerably, as is done in Troughton's tubular pendulum, where two brass tubes and five steel wires represent the nine rods of the regular gridiron, but the principle remains the same.

The *mercurial pendulum* is simply a steel rod carrying a jar of mercury, whose mass at once forms the weight or bob of the pendulum and its compensator; mercury being so expansible by heat that about 11½ pounds contained in a glass jar, so as to form a column about 6½ inches high, suffices to compensate the length of steel necessary to form a seconds' pendulum.

This pendulum is now employed almost universally for astronomical and other superior clocks, and really deserves the preference, both on account of the closeness to perfection with which it can be made and the readiness with which it is adjusted.

It may not be out of place here to notice, that in the final critical perfecting of this pendulum,—in the matter of the simultaneousness of expansion and contraction of all its parts,—and in the equalization of the mean and extremes in wide ranges of temperature, there are some laurels to win; to which, let us hope, Englishmen will not be indifferent.

(*To be continued.*)

ON THE PITCHINGS OF WHEELS AND PINIONS.

The perfection of pitchings is a part so essential in machines, particularly in those which measure time, such as clocks and watches, that too much care and attention cannot be given them. It has been thought necessary to mention here the effects which result in watches from bad pitchings, and to give afterwards the principles on which the theory of pitchings is founded, and, finally, to show the practical means of making good pitchings.

When the curves of the teeth are badly made, the wheel drives the pinion with different degrees of force; from whence it happens—1st, If this wheel communicates its force to a balance, that the balance loses its isochronism, or (which is the same thing) that it vibrates with different degrees of velocity, and that the time of vibration changes according to the different actions of the wheel on the pinion. 2dly, That the force of the mover to turn the pinion ought to be greater than would be requisite if the wheel made the pinion to turn in an uniform manner. This excess of motive force, of itself alone, tends (*independently of other variations*) to destroy the machine by the frictions which it causes, and these at length produce variations to the regulator.

If a wheel drives a pinion which is too large, or (which is the same) whose teeth or leaves are more distant from one another than those of the wheel, the force communicated by the wheel will in part be destroyed by the leaves of the pinion, which butt against the wheel teeth. This force so destroyed will require that a greater motive force be used to keep up the motion of the machine, from which will result friction, wearing, variations, &c.

If a wheel drives a pinion which is too small, or whose teeth or leaves are less distant than those in the wheel, it will happen that a tooth of the wheel acting on a lever or tooth too short, the pinion will turn with less force, and more velocity, as will be seen afterwards. It will again follow from this, that a part of the force of the wheel is lost, by the drop or fall of the tooth driving to that of the next which is to drive; the pinion will then turn with a part only of the force of the wheel. Thus the mover will require to have a greater power than it would have required if the wheel drove the pinion uniformly. This excess of force, and the inequalities of the pitchings, will tend to destroy the machine, and to make it vary, &c., as stated above.

And, *lastly*, when wheel-work is composed of wheels and pinions whose pitchings are

bad, in certain movements each wheel will act on its pinion with the greatest advantage, and then the force transmitted to the regulator will be the greatest possible; while in other instances, each wheel acting on its pinion with the least advantage, the force of the mover will be as it were almost annihilated, and the regulator (*pendulum* or *balance*) will receive only small impulsions. Now, the force of the mover ought to be sufficient for the least favourable case in the pitchings; it is then too great in the most favourable case; from whence arise the inconveniences which have been already remarked. Upon the whole, this is what results from badly-made pitchings.

To render a pitching the most perfect possible, and to avoid the inequalities of the curves of the teeth, in the case even of the driving after the line of the centres, pinions should be made with the greatest number of teeth or leaves, as of 8, 10, or 12, &c.; by this means we reduce to the least quantity the obstacles which arise from the driving before and after the line of the centres, and the curves of the teeth becoming insensible there results the least inequality, should they even be badly formed. For the pitching of pinions of 6 requires care to have them well-made, not only in determining the size, *which varies*, but in forming the curves exactly, and to avoid at the same time inequalities, butting, friction, &c.

It is to be observed, that the driving before and after the line of the centres differs according to the number of the teeth of the wheels and of the pinions; and, according to the proportion of the leaves of the pinions to the number of the teeth of the wheel; so it would be proper, that for each different number we made figures of teeth in large size, that thereby we could determine, in all cases, the driving before and after the line of centres, the sizes of the pinions, and the excess of the teeth of the wheel beyond the primitive radius; for it is again necessary to remark, that the sizes of pinions of 6, for example, or any other, differ according as they make a greater or less number of turns with regard to the wheel. Thus, a pinion of 6 which is driven by a wheel of 60 is of a different size from the pinion of 6 which is driven by a wheel of 30, even when the wheels should be of a size proportioned to their number of teeth, and the driving in both cases, not made equally before and after the line of their centres. Having fixed such principles, workmen, in following them attentively, will make good pitchings.

M. de la Hire seems to have been the first who showed how to trace the curve that was best adapted for the teeth of wheels and pinions, so as they might turn with an uniform motion. When a wheel turns a pinion, it may be said to *drive* it; and when a pinion turns a wheel, it may be said to be *leading* the wheel; the one being a quick, the other a slow motion.

To have a good or safe pitching, much depends on the proper size or diameter of the pinion, on the figure of the wheel teeth, and of the pinion leaves. If the pinions are high-numbered, that is, not less than eight or ten, any small deviation from a true figure may not be of so much consequence as some have attached to it. . . In the sizing of pinions, it is no doubt desirable to have them as large in diameter as they can safely be admitted, and rules for this purpose have been given by several artists,—founded on experience, and agreeable to the practice of the best workmen.

When the teeth of wheels are cut, and the diameter of pinions are required to be taken from them, callipers or spring pinion gauges are used. If, for example, it is required to make a pinion of 16 teeth, or leaves, give an extent or opening to the callipers, or gauge, so as to take in 6 teeth of the wheel, taken from the outer flank of the first tooth to the outer flank of the sixth;—this is what is called six *full* teeth.

For a pinion of—

15, the callipers must extend not quite to the flank of the sixth tooth.

14, take 6 teeth on the points, or middle of their tops.

12, five full teeth when it is for a large wheel of a clock; and when it is for a watch, take five teeth fully on the points.

10, four full teeth.

9, a little less than four full teeth.

8, for a clock, four teeth on the points; for watches, take four teeth on the points, less the fourth of a space of one tooth.

7, in a clock, three full teeth, and a fourth of a space of one tooth; for watches, take a little less than three teeth of the wheel, when finished, by forcing the callipers or gauge over them.

6, for clocks, take three full teeth; for watches, a little more than three teeth on the points.

5, three teeth on the points.

4, take two square and full teeth. When the pinion leads, take two square teeth of the wheel and a half of a space of one of the teeth more.

In general, all pinions which lead ought to be somewhat larger than those which are driven.—THOMAS REID, *On Clock and Watch-work.*

TRANSIT INSTRUMENT.

For the convenience of our readers we give, in connection with the abstract of Mr. Burr's Lectures, which appeared in a formei number of our Journal, an engraving anc description of a Transit Instrument, of the ordinary "portable" construction.

It consists, as will be understood from the before-mentioned abstract, of an achromati telescope, A, mounted on a hollow conica axis, B. The ends of this axis are ver truly and accurately turned, and rest in th fork of pieces of brass cut in the form of Y. These pieces have, the one an adjustmen up and down, or in altitude, and the other t and fro, or in azimuth, by means of screws the heads of which are not shown, to avoi complication. C is the level, supported b V-shaped notches upon the pivots of the axi and capable of being reversed end for en D is the vernier and tail-piece, which latter is secured by the bending screw E, so that the small spirit level at F, which is attached to it, shall have the bubble exactly in the centre. The ring G is graduated, and is fixed to the axis, and runs with it, so that the divisions on the circle being set by means of the vernier to the declination of the star, the telescope is in the right position for observing it when it comes to the meridian. H is the lamp for illuminating the transit wires *within the telescope.*

DESCRIPTION OF A

HALF-SECONDS CLOCK,

WITH SPRING REMONTOIRE ESCAPEMENT AND LAMINATED PLATE COMPENSATION PENDULUM.

Constructed and Made by THOMAS COLE, *No. 6, Castle-street, Holborn, London.*

This clock is made with the view to simplicity, economy, and correct performance; the escapement principle being that of the remontoire in its simplest form.

The escapement in this model consists of an escape wheel, A, of five teeth only, but may be made of any number suited to the respective train employed, and which wheel acts alternately on two linear steel springs, B, B; each spring being formed with a shoulder or pallet, C, near the free end, for locking the wheel teeth at every vibration of the pendulum in both directions of its motion, shewing half seconds on the dial by its present arrangement, or full seconds where a seconds pendulum is employed.

The wheel tooth, when locked on either side, holds the respective springs in tension, until unlocked by the pendulum rod coming in contact with the projectile end of the spring, so raised by the previous action of the wheel, which being at the same time released the wheel advances, and instantly raises the opposite spring into tension, and locks thereon, while the force of the first spring is exerted in giving impulse on the pendulum, at the commencement of the descending arc.

The arcs of vibration produced by this principle are invariable in any determined condition of the springs, but will admit of being made greater or less by opening or closing the projectile ends of the springs.

The employment of springs in this escapement instead of weights, for impulse on the pendulum, has the following advantages:—

1st. There being no pivots, there is no friction, and no oil required.

2d. There is no liability in this escapement to trip on the lockings, by the most extreme difference of power on the train from a going-barrel.

3d. Springs for impulse on the pendulum have the advantage of preserving a more uniform condition of strength, relatively to the strength of the pendulum suspension spring, irrespectively of the error on time by dilatation, which is corrected by the compensation for temperature; the three springs being under the same influence are better calculated than weight would be, for producing uniform results.

The pendulum bob is made of a spherical form, 1st, for concentrating the weight of matter in the smallest space; 2dly, for reducing atmospheric resistance; and 3rdly, for preventing the tendency to rotate with the axis of the rod.

The compensation for temperature in this clock is effected by a modified combination of two or more laminated plates of steel and brass; those plates sustaining the weight of the bob, either above or below the bob, and forming part of the mass.

These laminated compensation plates are formed as triangular arms from a centre through which the rod passes, the plates having perfect and frictionless contact with each other by three points of bearing, those points of contact being adjustible to or from the centre for increasing or diminishing the compensating power.

The general plan of supporting the clock on three or more columns has the advantage of stability, and affords the convenience of removing the movement when necessary without disturbing the pendulum.

This clock is intended to go eight days by once winding; and the calibre of the wheel work is so arranged as to bring the winding square outside the diameter of the dial, which prevents injury to it, or interference with the hands, which may be set by a button at the back of the dial without opening the glass.

FERGUSON'S MECHANICAL PARADOX.

[In conformity with our promise, we insert a more copious description of Ferguson's "Mechanical Paradox." It is given in the inventor's own words; and the Engraving is copied from his own Figures.—Ed. H. J.]

A person who has made but little progress in the mathematics, though in other respects learned and judicious, would be apt to pronounce it impossible that two lines, which were no where two inches asunder, may continually approach toward one another, and yet never meet, although continued to infinity; and yet the truth of this proposition may be easily demonstrated. And many, who are good mechanics, would be as apt to pronounce the same, if they were told, that although the teeth of one wheel should take equally deep into the teeth of three others, it should affect

them in such a manner, that in turning it any way round its axis, it should turn one of them *the same way*, another *the contrary way*, and the third *no way at all.*

On a very particular occasion, about eighteen years ago, I contrived a small machine of this sort, which has been shewn and explained to many; and which I shall here describe, and explain some of the uses it has been applied to.

It is represented to view by Fig. 1 of the annexed Engraving, in which A is called *the immoveable plate*, because it lies still on a table whilst the machine is at work. B C is a moveable frame, to be turned round an upright axis, *a*, (fixed into the centre of the immoveable plate) by taking hold of the knob *n*, which is fixed into the index *h*.

On the said axis is fixed the immoveable wheel D, whose teeth take into the teeth of the thick moveable wheel E, and turn it round its own axis, as the frame is turned round the fixed axis of the immoveable wheel D, and in the same direction that the frame is moved.

The teeth of the thick wheel E take equally deep into the teeth of the three wheels F, G, and H; but operate on these wheels in such a manner, that whilst the frame is turned round, the wheel H turns *the same way* that the wheel E does; the wheel G turns *the contrary way*, and the wheel F turns *no way* at all.

Before we explain the principles on which these three different effects depend, it will not be improper to fix some certain *criteria* for bodies turning or not turning round their own axes or centres; and to make a distinction between absolute and relative motion.

1. If a body shews all its sides progressively round toward a certain fixed point in the heavens, the body turns round its own axis or centre, whether it remains still in the same place, or has a progressive motion in any orbit whatever. For, unless it does turn round its own centre, it cannot possibly have one of its sides toward the west at one time, toward the south at another, toward the east at a third time, and toward the north at a fourth. This is the case with the Moon, which always keeps one side toward the Earth, but shews the same side to every fixed point of the starry heaven in the plane of her orbit in the time she goes once round her orbit, because in the time that she goes round her orbit she turns once round her own axis or centre. On the contrary, if a body still keeps one of its sides toward a fixed point of the heaven, the body does not turn round its own axis or centre, whether it keeps *in one and* the same place, or has a progres*sive motion in any orbit* or direction whatever. This is the case with the card of the compass in a ship, which still keeps one of its points toward the magnetic north, let the ship be at rest, or sail round a circle of many miles diameter.

Both these cases may be exemplified either by a cube or a globe having a pin fixed into either of its sides to hold it by: we shall suppose a cube, because its sides are flat. Sit down at a table, and hold the cube by the pin, which may be called its axis, and keep one of its sides toward any side of the room. Whilst you do this, you do not turn the cube round its axis, whether you still keep it in the same place, or carry it round any other fixed body on the table. But if you try to keep any side of the cube toward the fixed body, whilst you are carrying it round the same, you will find that you cannot do so without turning the pin round (which is fixed into the cube) betwixt the finger and thumb whereby you hold it; unless you rise and walk round the table, keeping your face always toward the fixed body on the table; and then both yourself and the cube will have turned once round; for the cube will have shewn the same side progressively round to all sides of the room, and your face will have been turned toward every side of the room, and every fixed point of the horizon.

2. If a ship turns round, and at the same time a man stands on the deck without moving his feet, he is turned absolutely round by the motion of the ship, though he has no relative motion with respect to the ship. But if, whilst the ship is turning round, he endeavours to turn himself round the contrary way, he thereby only undoes the effect that the turning of the ship would otherwise have had upon himself; and is, in fact, so far from turning absolutely round, that he keeps himself from turning at all; and the ship turns round him, as round a fixed axis; although, with respect to the ship, he has a relative motion.

Fig. 2 is a small plan, or flat view of the machine, in which the same letters of reference are put to the wheels in it as to those in *fig.* 1, for the conveniency of looking at both the figures in reading the description of them. W S E N is the round immoveable plate; D the immoveable wheel on the fixed axis in the centre of that plate; E the thick moveable wheel, whose teeth take into the teeth of the wheel D; and F is one of the thin wheels, over which G and H may be put, and then F, G, and H will make a thickness equal to the thickness of the wheel E, and its teeth will take equally deep into the teeth of them all. The frame that holds these wheels is represented by the parallelogram *a*, *b*, *c*, *d*; and if it be turned round, it

can give no motion to the wheel D, because that wheel is fixed on an axis which is fixed into the great immoveable plate.

Take away the thick wheel E, and leave the wheel F, where it lies, on the lower plate of the frame. Then turn the frame round the axis of the immoveable plate W S E N (denoted by A in *fig.* 1) and it will carry the wheel F round with it. In doing this, F will still keep one and the same side toward the fixed central wheel D, as the Moon still keeps the same side toward the Earth; and although F will then have no relative motion with respect to the moving frame, it will be absolutely turned round its own centre *g* (like the man on the ship whilst he stood without moving his feet on the deck), for the cross mark on its side next S will be progressively turned toward all the sides of the room.

But if we would keep the wheel F from turning round its own centre, and so cause the cross mark upon it to keep always toward one side of the room; or, like the magnetic needle, to keep the same point still toward one fixed point in the horizon; we must produce an effect upon F, resembling what the man on the ship did by endeavouring to turn himself round the contrary way to that which the ship turned, so as he might keep from turning at all, and by that means keep his face still toward one and the same point of the horizon. And this is done, by making the numbers of teeth equal in the wheels D and F (suppose 20 in each), and putting the thick wheel E between them, so as to take into the teeth of them both. For then, as the frame is turned round the axis of the fixed wheel D by means of the knob *n*, the wheel E is turned round its axis by the wheel D; and, for every space of a tooth that the frame would turn the wheel F in direction of the motion of the frame, the wheel E will counteract that motion by turning the wheel F just as far backward with respect to the motion of the frame, and so will keep F from turning any way round its own centre; and the cross mark near its edge will be always directed towards one side of the room. Whether the wheel E has the same number of teeth as D and F have, or any different number, its effect on F will be still the same.

If F had one tooth less in number than D has, the effect produced on F, by the turning of the frame, would be as much more than counteracted by the intermediate wheel E, as is equal to the space of one tooth in F; and therefore, whilst the frame was turned once round, suppose in direction of the letters W S E N on the immoveable plate, the wheel F would be turned the contrary way, as much as is equal to the space taken up by one of its teeth. But if F had one tooth more in number than D has, the effect of the motion of the frame (which is to turn F round in the same direction with it) would not be fully counteracted by means of the intermediate wheel E; for as much of that effect would remain as is equal to the space of one tooth in F; and therefore, in the time the frame was turned once round, the wheel F would turn, on its own centre, in direction of the motion of the frame, as much as is equal to the space taken up by one of its teeth: and here note, that the wheel E (which turns F) always turns in direction of the motion of the frame.

And therefore, if an upright pin be fixed into the lower plate of the frame, under the centre of the wheel F, and if the wheel F has the same number of teeth that the fixed wheel D has, the wheel G one tooth less, and the wheel H one tooth more; and if these three wheels are put loosely upon this pin, so as to be at liberty to turn either way; and the thick wheel E takes into the teeth of them all, and also into the teeth of the fixed wheel D; then, whichever way the frame is turned, the wheel H will turn *the same way*, the wheel G *the contrary way*, and the wheel F *no way* at all. The less number of teeth G has, with respect to those of D, the faster it will turn backward; and the greater number of teeth H has, with respect to those in D, the faster it will turn forward; reckoning *that* motion to be backward which is contrary both to the motion of the frame and of the thick wheel E, and *that* motion to be forward which is in the same direction with the motion of the frame and of the wheel E. So that the turning or not turning of the three wheels, F, G, H, or the direction and velocity of the motions of those that do turn round, depends entirely on the relation between their numbers of teeth and the number of teeth in the fixed wheel D, without any regard to the number of teeth in the moveable wheel E.

ON THE CAUSE OF ACCELERATION IN NEW CHRONOMETERS.

Among the errors yet left to be overcome in chronometers, the acceleration of rate is undoubtedly deserving of the greatest consideration, inasmuch as it makes a great amount of property useless for a considerable time. At least, the Greenwich trials show that, while the compensation can in many cases be made perfect, nearly all chronometers accelerate more or less on their rates, although some of them have been going for several years.

As no writers on horology have written anything upon this subject, and as individual

P

the field of the telescope, and almost in the plane of the system of wires. The shortest of these, *n*, marks units or single seconds upon the segment of a circle, *o p*, of 60°, which we may also suppose to be divided into ten parts, or tenths of seconds. The prolongations of the divisions 1, 3, 5, 7, 9, determine the distances of the wires in the field, so that they may give their aid in estimating the divisions of the scale. The coincidence of the disc with one of the wires, or its situation in the middle of one of the intervals between the wires, will therefore indicate one, two, or three tenths. The three needles, G, *m*, *n*, move in the same direction as the star in the astronomical telescope. There is a detent for stopping the wheel-work, and a lens near the eye for enabling it to read off the minutes and the tens of seconds upon the dial-plate E F.

"In using this instrument, the observer must notice upon the dial-plate E F, the minute and tens of seconds, a few seconds before the star has arrived at the wires; then raising his eye to the field of the telescope, he will observe by means of the shortest needle *n*, the units of seconds which are to be added. The eye of the observer must now be fixed solely on the star which is about to pass behind the first wire, and continuing to reckon the seconds, by observing laterally and indirectly the passage of the disc *m* over the divisions from 0 to 10. As the eye can never be removed for a moment from the star, the estimation of the eighteenths of seconds must always be performed by indirect vision. A little experience will obviously be necessary, to enable the practical astronomer to perform this operation with facility and confidence; and it is stated, that the instant of the transit of the star by the wire can thus be observed very distinctly to the tenths of seconds—with some practice, to the twentieth of a second, and even to some hundredths of a second by approximation. This ingenious invention may be applied to all kinds of telescopes, and will, we think, be found of great utility for various scientific purposes.

"There is one objection, however, of a practical nature, which we think it of consequence to mention, and which we fear is not susceptible of being removed. It has been shewn by Dr. Brewster, that when the eye is eagerly directed to the contemplation of one object, the retina is thrown into such a state, that circumjacent objects, seen by indirect vision, occasionally vanish and re-appear, so that if the degree of attention with which the astronomer is obliged to watch the motion of the star shall be found capable of throwing portions of the retina into a state of partial insensibility, he may lose sight of the disc at the very instant when it may be of the utmost importance to observe it."

By an appended note the Editor of the Edinburgh Philosophical Journal states, that he was unable to give a description of the interior arrangement of the chronometer. The original having been placed in my hands about a month since, I am enabled to supply the following particulars of the internal construction.

The numbers and arrangement of the wheel-work is as follows:—Suppose the minute hand, belonging to the circle of ten minutes, to be carried by the prolonged arbor of the third pinion of the movement train; the number of the third wheel on this pinion must be 80, driving the fourth pinion of 8 leaves; the fourth wheel on its pinion may also be 80, driving the scape pinion, also of 8 leaves, carrying the escapement wheel of 15 teeth. The mechanism of this instrument, though called a chronometer, must be understood to act in the manner of the horizontal or lever escapements, where the impulse is equally divided, so that the scape wheel of 15 teeth will give 30 beats, making a complete revolution in six seconds. On the arbor of the scape pinion, outside the frame plate, is fitted a collet carrying six needle-formed arms, the radial length of which extends beyond the radius of the scape wheel sufficiently to reach over the field of the telescope, the end of each arm carrying a small disc.

The train in this case is of course 18,000, giving five beats per second.

Your's respectfully,

JAMES F. COLE.

July 18th, 1859.

PROTECTION FROM RUST.

To the Editor of the Horological Journal.

Sir,—Polaris, at page 24, in his objections to the method I suggested for the protection of the balance spring of the chronometer from rust, states correctly the action that takes place in the cell of a battery and in the case of a ship's sheathing, but over-calculates the amount of the protection required in this case, for it is not supposed that the chronometer to which it might be attached would needlessly be exposed to more than the average of damp.

I also contemplated the clearing of the surface of the protector every time the chronometer required cleaning, which, as it would form only dead weight, could be done without materially affecting the piece's rate.

The principal question, however, seems to me, the way in which galvanic arrangement such as that suggested would comport itself, the exciting fluid being gaseous instead of liquid. I am, your's obediently,

GNOMON.

CLOCK AND WATCH-MAKERS' ASYLUM.

Too much praise cannot be given to the executive of this Institution for their indefatigable exertions in placing the Asylum in the high position it now holds. May it continue

to prosper! is our fervent desire; so that it may not only be an honour to the trade, but, by the blessing of Providence, a boon to the poor and helpless. It is therefore with much pleasure we have to state, that on the 11th ultimo an election of a further number of recipients of the benefits of the Asylum, viz., of two males and one female, took place at the Crown Tavern, Clerkenwell Green, G. Carley, Esq. in the chair.

The minutes of the annual meeting of February were read by the Secretary, Mr. C. J. Breese, and confirmed by the meeting.

Messrs. Castro, E. J. Thompson, and Overan were elected Scrutineers of votes.

The ballot having been kept open from 7 o'clock till 9 o'clock, about 20 minutes past 10 the scrutineers made their report; whereupon

The Chairman announced the result as follows:—Females—Mrs. Sheppard, 1671; Mrs. Andrews, 723; and Mrs. Platt, 21. Males—Mr. Stiles, 1554; Mr. Gilling, 999; Mr. Burwash, 907; Mr. Boyce, 516; Mr. Clarke, 128; and Mr. Hamilton, 125.

The Chairman then declared that Mrs. Sheppard, Mr. Stiles, and Mr. Gilling were the successful candidates.

The Chairman congratulated the meeting that the Society had been so far successful as to be enabled to hold the second election so early. They had much to be thankful for in the attainment of that result, especially looking at the depressed state of the trade Three more inmates were added to those who were at present enjoying the benefits of the Asylum. That prosperity had not so much resulted from themselves as members of the trade, as it had from those kind-hearted and excellent Ladies who had so generously furnished the means of holding the bazaar. To them was owing the liberal contribution of articles for sale, and the great success which had attended the bazaar, notwithstanding the drawback of extremely unfavourable weather; but for the proceeds of that bazaar the members of the Asylum would not then be exercising their votes in the election of candidates. The future of the Asylum was rather hopeful. Its treasury was not empty, nor did its condition look very despicable. He was inclined to think that, with the continued co-operation of the trade, they would be able to have another election during the present year. In making that statement he was not speaking officially, but merely expressing his private opinion. He really thought they ought to fill the entire of the houses during the next year. By that time he trusted they would see such a decided improvement in the business, and that their subscriptions would be augmented to so great a degree, that they would be enabled to go to work and fill the Asylum.

Votes of thanks were passed to the Chairman and Scrutineers, and duly responded to, and the meeting separated.

MULTIPLYING POWER OF WHEELS AND PINIONS.

If the multiplying power, or number of revolutions produced at the last wheel of any number of wheels and pinions, all various, and geared in succession in the manner of an ordinary train, be of any expressed amount—say, for example, as by the train of an ordinary watch, there will be no difference in result of motion by any change in the arrangement, supposing other wheels and pinions of the same numbers as the former, differently sized to suit each other, under any change of connexion between the respective wheels and pinions, as in the two following reverse cases:—

Great	Wheel	84	in	Pinion	12	=	7 times
Centre	Wheel	75	in	Pinion	10	=	7½ times
Third	Wheel	72	in	Pinion	9	=	8 times
Fourth	Wheel	80	in	Pinion	8	=	10 times
Great	Wheel	84	in	Pinion	8	=	10½ times
Centre	Wheel	75	in	Pinion	9	=	8⅓ times
Third	Wheel	72	in	Pinion	10	=	7⅕ times
Fourth	Wheel	80	in	Pinion	12	=	6⅔ times

The effect will of course be relatively the same by any other train of wheel work, however extended or diversified.

J. F. Cole.

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

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(*Continued from page* 127.)

1799, November 4.—No. 2351.

GOUT, Ralph.—The title of this invention is as follows: "Certain new improvements on pedometers "and pedometrical watches, for the purpose of "ascertaining more accurately, and with greater "precision, the number of steps the wearer makes in "walking, and, when affixed to a saddle, the number of "paces the horse makes; and also, when affixed to a "curricle or other carriage, the number of revolutions "of the wheel."

1. The first sort is placed in the fob, and is acted on in the usual way by a pusher.

2. A pedometer of any sort is fixed to the saddle, and is acted on by a small machine fixed to it; at the bottom of which is a crank to which an elastic martingale is attached. Every step of the horse pulls the crank, which acts on one end of a lever inside the machine, and thus the pedometer receives its impulse. The lever is recalled to its place again by a small spiral spring.

3. In a carriage, the pedometer is fixed in machinery similar to that for a saddle, save that the crank is omitted. The machinery is screwed on the axletree, and the pedometer receives its impulse by a tooth on the nave of the wheel acting on a tooth which is placed on an arbor inside the machine, and thus marking the revolution.

[Printed, 7*d*. See Repertory of Arts, vol. 13, p. 73.]

1803. April 20.—No. 2700.

DAY, Samuel.—A watchman's tell-tale or time-keeper. A horizontal wheel has on its upper surface a dial showing the hours, and round its edge or side are also marked the hours. The part of the surface outside the surface dial is divided into cells, each cell corresponding with the quarter of an hour, or, if the number be increased, with every five minutes. By means of a smaller wheel and pinion the large wheel is set in motion by ordinary clock work placed below, and is made to go round once in 12 hours. As it moves round, it carries the cells under a chink, which sinks down from a box above the wheel. The whole machine is placed in a locked-up case. There is, however, a small door which will open to give access to the chink. The instrument may be used for a variety of purposes, such as the following :— A watchman, at the end of every beat, may be obliged to drop a numbered token down the chink. It falls into one of the cells, and marks the exact time when it was dropped in.

Under the aforesaid box is an aperture to show the hours marked on the side of the wheel, and below that is a minute dial. These can be seen by opening the aforesaid door.

[Printed, 7*d*. See Repertory of Arts, vol. 3 (*second series*), p. 161.]

1803, May 28.—No. 2706.

GOULD, Chester.—" A glass on a new principle, " to be used by mariners at sea, instead of the common " sand glasses, when heaving the log." A hollow glass globe, about the size and shape of an orange or egg, with a hole at each end, the holes being of such sizes respectively that the glass, being filled with water, will empty itself at one end in half a minute, at the other in 15 seconds. The aforesaid size, shape, or time, may be varied.

[Printed 3*d*. See Repertory of Arts, vol. 3 (*second series*), p. 243 ; and Rolls Chapel Reports, 6th Report, p. 152.]

1804, May 14.—No. 2759.

ELLIOT, Joseph Moseley.—" Repeaters upon a " new and improved principle, so as to repeat the " hours, quarters, half-quarters, or every five minutes, " the hour first and then the divisions thereof, or the " divisions of the hour and then the hour, by turning " the pendant either to the right or left, with one " hammer only, and which may be made either bell or " dumb repeaters." By moving the pendant to the right, a small pallet acts in a rack, and causes a lever inside the watch to turn on its axis until one of two arms rests against the hour snail and is stopped, the hammer meanwhile being acted on by means of the hour rack. By moving the pendant the contrary way, a similar action takes place with regard to the quarter snail. Either operation may be done first, and as soon as one is performed the lever is brought back again by a spring barrel.

[Printed, 5*d*. See Rolls Chapel Reports, 6th Report, p. 153.]

1805, March 26.—No. 2834.

BOND, George Alexander.— The dial plate is made of some transparent substance, and a light is placed behind, so that, the figures on the dial and the hands of the clock or timepiece not being transparent, the time can be seen in a dark room. In order that the mechanical part of the clock may not intercept the light, the dial plate may be advanced, and the light placed between it and the part which contains the works ; or such part may be made small, and the dial large ; or the movement part may be placed below, or on one side of the dial.

2. An improvement in enamelled dials, by making a plate of enamel by itself of sufficient thickness to admit of polishing. This is fixed on a metal plate by cement, or by being set as in jewellery.

[Printed, 5*d*. See Repertory of Arts, vol. 7 (*second series*), p. 161 ; and Rolls Chapel Reports, 6th Report, p. 153.]

1805, November 19.—No. 2893.

DE LAFONS, John.— A marine alarum, which is a substitute for the half and quarter glasses used at sea. A wheel with ratchet teeth turns on an arbor, which passes through the plates, and carries a handle, and is propelled forward by the main spring. Connected with this arbor is a click which is held by the ratchet teeth of the said wheel. As the wheel revolves the click is discharged from the teeth, which gives liberty to the arbor to turn on its centre, and the handle affixed on it strikes a bell. This handle also strikes a nut, which causes a pump piece to move, and to drop a pin into the escape wheel, and the machine is thus stopped. The piece thus stopped will remain so, when the handle is turned to the quarter or half minute or other time, until the nut is pressed down, which discharges the pin out of the escape wheel, at the exact moment required. A spring bears against the pump piece to keep it in its place when either up or down. The said wheel, "when designed for " nautical purposes, turns a pinion with a crown or " balance wheel, which acts in a common verge and " balance, with fans or flys to adjust it accurately to " time." The patentee also makes his machines with a rack or portion of a wheel, which, when it has acted on the pinion, will drop off by the power of the main spring, and the rack itself, or any piece affixed thereto strike the bell. The nautical machine may also be made with an escapement and discharge.

[Printed, 5*d*. See Repertory of Arts, vol. 9 (*second series*), p. 3.]

1806, October 30.—No. 2983.

ELLIOT, Joseph Moseley.—" New improved " method of making and constructing repeaters or

"repeating watches and timepieces." By this method watches and timepieces may be made to repeat, not only the hour and quarter, but also to the last minute, with one hammer only, without the usual train of wheelwork.

[Printed, 5*d.* See Rolls Chapel Reports, 7th Report, p. 103.]

1807, December 5.—No. 3085.

MANTON, Joseph.—"An instrument or machine "for timekeepers to act in vacuum, so constructed that "they may be wound up in vacuum when required "without admitting the external air."

[Printed, 3*d.* See Repertory of Arts, vol. 16 (*second series*), p. 327.]

1808, January 26.—No. 3102.

SAVAGE, George.—A method of regulating the force or power of the mainspring, by the introduction of a minor spring, to be wound up by the main spring at certain periods. As the wheels revolve, some pins placed in a small circle in the hour wheel force up a lever, which, by means of a pallet, unlocks a quarter-piece which covers the minor spring. This operation causes the main spring to wind up the minor spring, and administers an equal impelling power to move the train of wheels.

[Printed, 5*d.* See Repertory of Arts, vol. 12 (*second series*), p. 349; and Rolls Chapel Reports, 7th Report, p. 105.]

TO CORRESPONDENTS.

*** *All Communications for the Editor to be addressed to* 35, Northampton Square, London, E. C.

J. A. Davis.—The pages of this Journal are especially devoted to Horology *and the Allied Sciences.* These latter are very extensive, and we should feel at liberty to introduce any subject actually bearing or likely to bear upon our great and primary object.

A Well-wisher.—The donation of One Pound has been received and handed over to the Secretary of the British Horological Institute.

Declinations of the following Stars, and Times at which they are on the Meridian at Greenwich, for August, 1859.

Name of Star.	Day of Mon	Dec. North °	′	″	Greenwich Mean Time of passing the Meridian. h.	m.	s.
α Lyræ (*Vega*)	9	38	38	84·4	9	20	52·40 P.M
	19	38	38	86·5	8	41	33·15 ,,
	29	38	38	88·2	8	2	13·87 ,,
α Aquilæ (*Altair*)	9	8	29	64·0	10	32	25·64 P.M
	19	8	29	65·4	9	53	6·61 ,,
	29	8	29	66·6	9	13	47·36 ,,
α Pegasi (*Markab*)	9	14	26	68·4	13	45	43·95 P.M
	19	14	26	70·5	13	6	25·01 ,,
	29	14	26	72·4	12	27	6·04 ,,

EQUATION OF TIME TABLE

For August, 1859.

Day of the Week	Day of Mnth	At Apparent Noon — Equation of Time to be *added* to Apparent Time. m.	s.	Difference for One Hour. s.	At Mean Noon. — Equation of Time to be *subtracted* from Mean Time. m.	s.
Mon...	1	6	4·54	0·147	6	4·55
Tues..	2	6	1·01	0·173	6	1·03
Wed ..	3	5	56·87	0·198	5	56·89
Thurs.	4	5	52·12	0·224	5	52·14
Fri. ..	5	5	46·75	0·250	5	46·77
Sat. ..	6	5	40·75	0·275	5	40·78
Sun. ..	7	5	34·14	0·300	5	34·17
Mon...	8	5	26·93	0·325	5	26·96
Tues..	9	5	19·12	0·350	5	19·15
Wed ..	10	5	10·71	0·374	5	10·74
Thurs.	11	5	1·72	0·398	5	1·75
Fri. ..	12	[illegible]	52·16	0·422	4	52·19
Sat. ..	13	4	42·03	0·445	[illegible]	42·06
Sun. ..	14	4	31·35	0·467	4	31·39
Mon...	15	4	20·13	0·489	4	20·17
Tues..	16	4	8·40	0·510	4	8·43
Wed ..	17	3	56·14	0·531	3	56·17
Thurs.	18	3	43·39	0·551	3	43·42
Fri. ..	19	3	30·15	0·571	3	30·18
Sat. ..	20	3	16·44	0·590	3	16·47
Sun. ..	21	3	2·26	0·609	3	2·29
Mon...	22	2	47·64	0·627	2	47·67
Tues..	23	2	32·58	0·645	2	32·61
Wed ..	24	2	17·10	0·662	[illegible]	17·13
Thurs.	25	2	1·22	0·679	2	1·24
Fri. ..	26	1	44·93	0·695	1	44·95
Sat. ..	27	1	28·24	0·711	1	28·26
Sun. ..	28	1	11·18	0·726	1	11·20
Mon...	29	0	53·76	0·741	0	53·77
Tues..	30	0	35·97	0·755	0	35·98
Wed ..	31	0	17·86	0·769	0	17·86

TO ADVERTISERS.

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The Horological Journal.

VOLUME II.

SEPTEMBER 1, 1859.

TO OUR READERS.

WITH the present Number we commence a New Volume, and it is usual on similar occasions to say a word or two to those who have accompanied us thus far in our literary career.

The history of the HOROLOGICAL JOURNAL is of rather a peculiar character. It was not established as a commercial speculation, and was not intended to furnish either gain or amusement to its promoters. It was intended as one of the features of the BRITISH HOROLOGICAL INSTITUTE, and had for its object the publication and dissemination of practical and scientific knowledge relating to Horology. It was also placed on the footing of the Journals and Transactions published by our various learned Societies, each member of the Institute being furnished with a copy. The subject-matter has been contributed almost entirely by those who originated the Institute, and the work of editing has been performed by officers of that body.

It is not for us to speak in our own praise as to the literary and scientific merits of our Journal; but, as a proof of success, we may mention that the public sale now nearly pays the expenses of printing and publishing, and we are thus able to circulate it among the members of the Institute without charge on their funds.

It unfortunately happens that Clock and Watch Makers are not necessarily literary. *We* feel this rather keenly at the present moment, and find therein a greater reason for the establishment and encouragement of an Institution which will not only have the effect of teaching watchmakers more, but also of enabling them to immortalize and render permanent the results of their studies. How many valuable inventions have been lost, not only to the public, but also absolutely to the inventor himself, for the want of ability to record their details with pen or pencil! Where would Sir Isaac Newton's greatness have been, had he not been able to communicate his discoveries to the world? Of what avail would have been the contrivances of Hooke, of Graham, of Harrison, and of Arnold, had they not, in addition to mechanical talent, possessed the power of registering their labours for posterity?

It may be supposed by some that the knowledge necessary for the purpose now adverted to is incompatible with the pursuits of a practical watchmaker,—that the pen cannot be wielded by the same hand as the graver, or the pencil be allowed to lie by the side of the mandrel. This is a very great mistake. There is no profession in which the pen and the pencil can do more service for their owners than among watchmakers; and there is no trade in which ability, and the will to use them, will not more surely raise the possessor among his fellows.

We must confess to a little complacency when we find that, in spite of obstacles, we have been enabled to complete our First Volume, and, more than this, to find that our prospects are infinitely better than they were at first. The treatise on Horology which has appeared in our pages has been exclusively written for the Journal; and it is hoped that it will, when finished, present a complete epitome of the general history of the subject from a Watchmaker's point of view. We have been able to reprint several scarce papers of interest, and we have in preparation others which deserve to be republished. One of them we commence in the present number, in the form of a Memoir by Le Roy on Marine Timepieces, valuable for its depth of research and exactness of result, and mechanically worthy of notice, as describing a method of compensation by mercurial tubes which has been revived in our own day by Mr. Loseby.

The courtesy of the Honourable Commissioners of Patents enables us to republish abstracts of all Patents relating to Watchmaking, the most remarkable being reproduced in full, with Engravings. We hope that this with other matters will make our Journal valuable as a work of reference, as any intending patentee may find almost at a glance whether he has been anticipated or not.

We also propose to insert a collection of Tables relating to various matters connected with our art, obtained from the best sources. We shall be glad to receive any such of value which our readers may meet with; at the same time it must be understood that we shall not hold ourselves responsible for the correctness of any that we have not ourselves calculated, but will in all cases, when practicable, give the name of the author, as the one responsible for accuracy.

We are happy to say that the British Horological Institute continues to flourish. By this we mean, that the number of its members is increasing,—that its influence is spreading,—and that its primary object, namely, the union of the Trade as a society of scientific men, is more likely to be accomplished than when we commenced our Journal. The recent election for officers demonstrated the fact, that it is worth while even to contend for office in its ranks.

WHAT IS HOROLOGY?

(Continued from page 159.)

Mudge's Improvements in Timekeepers.

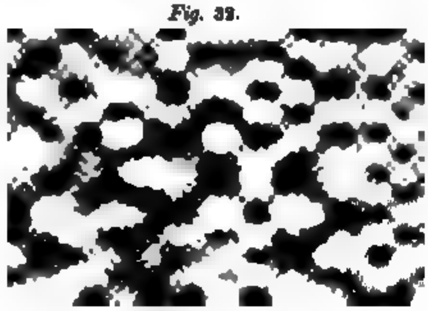
The last portion of the reward of £20,000 offered by the Act of Queen Anne was paid to Harrison in 1774; and a new Act was immediately passed, limiting the reward for the future to £10,000, and also prescribing a closer rate for the successful timekeeper. By the first act the chronometers were allowed four minutes of error in six weeks; but, by the act of 1774 the same amount of error was not to be exceeded in six months. Just previous to the passing of the new Act, Mr. Thomas Mudge had completed and proved a chronometer, which was similar in many respects to Harrison's. In consequence of not making application for the trial of his timekeeper at a sufficiently early period, Mudge was obliged to compete for the diminished reward attached to the more accurate rate of performance prescribed by the new regulations. The result of this was, that the chronometer exceeded the limits of error allowed by the last act while it was much within those under which Mudge had hoped it would have been tested. In the four trials made of the timekeepers of Mr. Mudge by Mr. Maskelyne from the years 1776 to 1790 (the first of which trials was of No. 1 in 1776, 1777, and 1778, and the second, third, and fourth, of the pieces denominated "Blue" and "Green," in 1779 and 1780, again in 1783 and 1784, and subsequently in 1789 and 1790) it appeared from the reports to the Board of Longitude that none of the timekeepers had kept time within the limits of the act of Geo. III. On the 1st of March, 1777, however, the Astronomer Royal reported to the board that the first watch made by Mr. Mudge had only gained 1m. 19s. in 109 days; in consequence of which it was resolved that £500 should be paid to Mr. Mudge to enable him to finish two new chronometers on a similar construction; but, after this, the mainspring of No. 1 broke, and when replaced the piece was found, on a trial of 15 months, to have gained daily 8·6 seconds at the end more than at the beginning of the trial. Some unpleasant disputes arose between Mr. Mudge and the authorities with respect to these trials, the details of which have been fully published in certain "Narratives" and "Answers," more probably to the gain of the printers than of those who thus appealed to the public. Mr. Mudge went so far as to petition the House of Commons for an inquiry into the principles of construction of his timekeeper, and a committee was appointed for the purpose. The members of this committee, with the addition of a subcommittee of practical and scientific men, drew up a report, in which they speak favourably of Mudge's plan for equalizing the force of the mainspring, and also of the ingenuity and excellence of workmanship displayed throughout the piece. At the same time they give it as their opinion, that no "judgment can be formed of the exactness of any timekeeper by theoretical reasoning upon the principles of its construction, with such certainty as with safety to be relied on, except it be confirmed by experiments of the actual performance of the machine."

They also stated that chronometers No. 36 and 68 of Mr. Arnold's construction had gone with a degree of accuracy greater than could be shewn on any corresponding trial of Mr. Mudge's, and at the same time declare it as their opinion that Mudge's improvements "were likely to conduce to advantages sufficiently important to attract the notice of Parliament." On these grounds, and also from the fact that Mr. Mudge "had spent his energies in the hope of benefiting the public rather than to enrich himself, they recommend the petitioner to the attention of the House." Accordingly, in the year 1793, after the examination of various witnesses, and in spite of the opposition of the Board of Longitude, the House of Commons awarded to Mr. Mudge the sum of £2500 in addition to the £500 already received by him.

The younger Mudge established a manufactory for the production of chronometers on his father's principle, but he was a great loser by the speculation, although the price put upon them was 150 guineas each; for by this time Arnold and Earnshaw had entered into the field, and supplied their timekeepers at a reduced price.

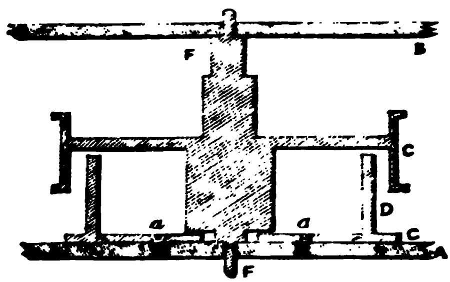
We have stated that Mudge's timekeeper was similar to Harrison's in various points. The chief of these was in the escapement, which was on the remontoire principle. The barrel also was of a similar construction, and is shewn in *fig.* 32. A is the edge of the upper

Fig. 32.



plate, and B of the pillar plate of the frame; the barrel is composed of two distinct parts, C and D, which together may be denominated an entire box, of which D is the body or box portion, and C the cover or lid. This lid C is called by Mudge the chain barrel, and the box part, D, the spring barrel. A section is seen at *fig.* 33, where the same letters refer

Fig. 33.



to the same parts. It may thus be seen that C may revolve with its arbor, E F, separately from the other portion, D. G in both figures is a ratchet wheel, made in the form of a rim or ring, with its teeth on the outer surface, and is fastened to the lower end of the rim of the box D, so that a small part projects into the box. This has a shoulder, making the part within thinner than that without, as in *fig.* 33. The bottom of the box, *a a*, is detached, and just enters inside the box; it has a corresponding shoulder at the circumference of its lower plane, which rests on the first shoulder in the concave projecting part of the ratchet. The box with its loose bottom is placed on the plane of the plate A, and the bottom *a a*, perforated for the revolving arbor, is secured to it by screws, so that though the box is attached to the plate by its bottom, its rim with the ratchet is at liberty to turn while the bottom is at rest, and the motion of the ratchet will be free or impeded in proportion to the quantity of pressure which the fixing screws occasion on the two shoulders already described. A click screwed to the plate A, and taking into the teeth of the ratchet C, will hold the box from going back, but will leave it at liberty to revolve in the opposite direction. Suppose the spring hooked in the usual way to the inside of the barrel and to the barrel arbor, and the chain coiled round the barrel or lid C, it will then be seen that when the chain is wound away by the fusee, it will pull the arbor round, and the inner end of the spring will come into action first, and each coil will follow successively up to the centre.

The chain is wound round the fusee in a direction which moves the wheels of the train backwards, requiring an additional wheel in the dial work. With a fusee of $7\frac{1}{4}$ turns the piece goes for 36 hours.

We abridge the following description of the escapement and compensation from Dr. Pearson's account:—

Fig. 34.

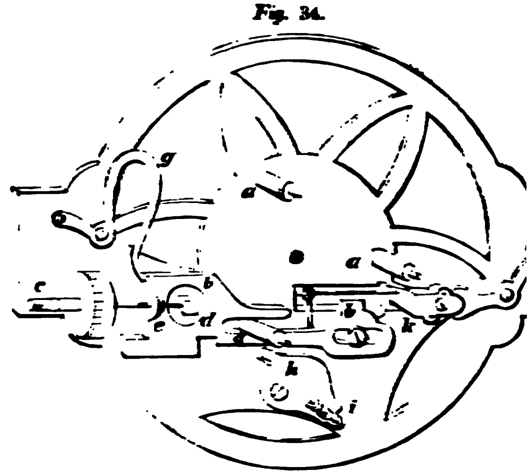


Fig. 34 is a perspective view of the cock of Mudge's timepiece. Three pillars, *a a a*, support a smaller concentric frame bearing four friction rollers; the pivot of the balance arbor runs in the central point where the four rollers nearly meet, and touches the circumferences of each, so as to produce a rotatory motion in each that lessens the friction at the pivot: *b b* is a metallic sliding piece, filed away on the side next the centre to avoid the regulating spring, and placed on the plane of the cock to adjust one of the curb pins for regulating the piece which it carries underneath it. The cock has an oblong slit in it, near the screw at *b*, for the pin to move backwards and forwards during the act of adjustment, and the slider itself has two oblong slits, which admit of a longitudinal motion, and also keep it in its place during adjustment. At *c* is an arbor, square at the end to admit a key, but round below. This has a fine screw at the remote end, which presses against a stud *d* in the cock where there is a third opening for the stud, the part *e* being turned up and tapped to suit the screw on the arbor of adjustment. Between *e* and *c* is a nut, divided into 30° on its edge, which is indexed by a straight line in the stationary piece through which the arbor passes. There is also a scale at *f*, attached to the large cock, to which a line on the slider points, and moves one space for every entire turn of the screw. *g* is a spring placed on the cock to force back the slider when the screw has a retrograde motion. The slider is held down to the plane of the cock

by the screw near *b* at the curb pin, and also by a collet going over the stud *d*, and pinned on. There is a second curb pin fixed on a detent, or straight piece of steel riveted to the under side of the piece *h*, and crossing the slider at right angles. This curb pin is borne by the interior extremity of the detent, and the adjustment is made by the screw and studs *e*, screwed into the cock, and fitted sideways into two notches in the piece *h*, the screw on which holds the whole down, *k* is the stud of the regulating spring, and *l* a piece intended to cover the second screw of the large cock, which screw cannot be removed until the cover is taken off, and the cover cannot be removed until the spring stud is removed. This is necessary in order to secure the spring from injury in taking down.

Fig. 35.

Fig. 35 exhibits the second balance spring and mechanism of compensation, as they appear when the cock in *fig.* 32 is removed from the upper plate of the frame. *a a* is a piece of brass screwed to the plate by the three screws *d d d*; *e* and *f* are two similar compensation bars, composed of brass and steel soldered together, with their positions reversed, that is, the piece *e* has the brass side next to *e*, and the piece *f* has the steel side next to *f*. These compound pieces, seen in a detached state in *fig.* 36, with their interior curved ends passing each other, are screwed by two screws at their outer ends to the similar pieces *g* and *g*, which are themselves screwed to the long piece *a a*, but in such a way as to be adjustible when the screws are not home. The adjustment is made by the two similar screws at *h* and *h*, which fit the studs that appear at *i* and *i* in the apertures of the pieces *g g* left for the studs; and by these and two other smaller studs, *k* and *k*, is preserved the parallelism of the motion of adjustment. *l l* is a lever or detent, carrying a curb or piece with two pins at the upper end, a little distance from the stud *m* of the regulating spring, and having a curve to avoid the balance verge, together with two short levers near the rounded projection of the cocks *b* and *c*. This detent is fixed on an arbor which is pivoted above into the cock *b*, and below into the foot *n* of the cock *c*, which is let down out of sight through an aperture in the plate. The lever of the detent is prolonged back to a considerable distance behind the cock to the end *g* of the cross piece of *a a*, in which is described an arc of a circle divided into 20 equal parts, to indicate as a thermometer the situation of the curb at any particular time.

The action of the compensation bars, in the timekeeper denominated "Blue," is as follows. Brass being more elongated by heat and more contracted by cold than steel, the compound bar *e* with the brass side next to *e* will become concave on the brass side in cold weather, and its remote end being fast by the screws to the fixed piece *g*, the interior end will move forward and press below the remote tail piece of the detent, which will then move and bring the curb towards *o*; the other compound bar, *f*, in the mean time becoming convex on the side *f* will make way for the motion of the other tail piece that points to *e*, by falling back at the same rate with which the other bar moves forward; while in heat the contrary of these motions will take place. In the first case the effective length of the spring will be increased, and in the latter decreased.

(To be continued.)

FERGUSON'S MECHANICAL PARADOX.

(*Continued from page* 165.)

Having solved the paradox, and described the cause of the different effects which are produced upon the three wheels F, G, and H, we shall now proceed to shew some uses that may be made of the machine.

This machine is so much of an Orrery, as is sufficient to shew the different lengths of days and nights, the vicissitudes of the seasons, the retrograde motion of the nodes of the Moon's orbit, the direct motion of the apogeal point of her orbit, and the months in which the Sun and Moon must be eclipsed.

On the great immoveable plate A (see *fig.* 1.) are the months and days of the year, and the signs and degrees of the zodiac, so placed, that when the annual index *h* is brought to any given day of the year, it will point to the degree of the sign in which the Sun is on that day. This index is fixed to the moveable frame B C, and is carried round the immoveable plate with it, by means of the knob *n*. The carrying this frame and index round the immoveable plate, answers to the Earth's annual motion round the Sun, and to the Sun's apparent motion round the ecliptic in a year.

The central wheel D (being fixed on the axis *a*, which is fixed in the centre of the immoveable plate) turns the thick wheel E round its own axis by the motion of the frame; and the teeth of the wheel E take into the teeth of the three wheels F, G, H, whose axes turn within one another, like the axes of the hour, minute, and second hands of a clock or watch, where the seconds are shewn from the centre of the dial-plate.

On the upper ends of these axes are the round plates I, K, L; the plate I being on the axis of the wheel F, K on the axis of G, and L on the axis of H. So that, whichever way these wheels are affected, their respective plates, and what they support, must be affected in the same manner; each wheel and plate being independent of the others.

The two upright wires M and N are fixed into the plate I; and they support the small ecliptic O P, on which, in the machine, the signs and degrees of the ecliptic are marked. This plate also supports the small terrestrial globe *e* on its inclining axis *f*, which is fixed into the plate near the foot of the wire N. This axis inclines 23½ degrees from a right line, supposed to be perpendicular to the surface of the plate I, and 66½ to the plane of the small ecliptic O P which is parallel to that plate.

On the Earth *e* is the crescent *g*, which goes more than half way round the Earth, and stands perpendicular to the plane of the small ecliptic O P, directly facing the Sun Z: its use is to divide the enlightened half of the Earth next the Sun from the other half which is then in the dark; so that it represents the boundary of light and darkness, and therefore ought to go quite round the Earth; but cannot, in a machine, because, in some positions, the Earth's axis would fall upon it. The Earth may be freely turned round on its axis by hand, within the crescent, which is supported by the crooked wire *w*, fixed to it, and into the upper plate of the moveable frame B C.

In the plate K are fixed the two upright wires Q and R: they support the Moon's inclined orbit S T in its nodes, which are the two opposite points of the Moon's orbit where it intersects the ecliptic O P. The ascending node is marked ☊, to which the descending node is opposite, below *e*, but hid from view by the globe *e*. The half ☊ T *e* of this orbit is on the north side of the ecliptic O P, and the other half *e* S ☊ is on the south side of the ecliptic. The Moon is not in this machine; but when she is in either of the nodes of her orbit in the heavens, she is then in the plane of the ecliptic: when she is at T in her orbit, she is in her greatest north latitude; and when she is at S, she is in her greatest south latitude.

In the plate L is fixed the crooked wire U U, which points downward to the small ecliptic O P, and shews the motion of the Moon's apogee therein, and its place at any given time.

The ball Z represents the Sun, which is supported by the crooked wire X Y, fixed into the upper plate of the frame at X. A straight wire W proceeds from the Sun Z, and points always toward the centre of the Earth *e*; but toward different points of its surface at different times of the year, on account of the obliquity of its axis, which keeps its parellelism during the Earth's annual course round the sun Z; and therefore must incline sometimes toward the Sun, at other times from him, and twice in the year neither toward nor from the Sun, but sidewise to him. The wire W is called *the solar ray*.

As the annual index *h* shews the Sun's place in the ecliptic for every day of the year, by turning the frame round the axis of the immoveable plate A, according to the order of the months and signs, the solar ray does the same in the small ecliptic O P: for, as

this ecliptic has no motion on its axis, its signs and degrees still keep parallel to those on the immoveable plate. At the same time, the nodes of the Moon's orbit S T (or points where it intersects the ecliptic O P) are moved backward, or contrary to the order of signs, at the rate of 19⅓ degrees every *Julian* year; and the Moon's apogeal wire U U is moved forward, or according to the order of the signs of the ecliptic, nearly at the rate of 41 degrees every *Julian* year; the year being denoted by a revolution of the Earth *e* round the sun Z; in which time the annual index *h* goes round the circles of months and signs on the immoveable plate A.

Take hold of the knob *n*, and turn the frame round thereby; and in doing this you will perceive that the north pole of the Earth *e* is constantly before the crescent *g*, in the enlightened part of the Earth toward the Sun, from the 20th of March to the 23d of September, and the south pole all that time behind the crescent in the dark; and, from the 23d of September to the 20th of March, the north pole is constantly in the dark, behind the crescent, and the south pole in the light before it: which shews, that there is but one day and one night at each pole in the whole year; and that when it is day at either pole, it is night at the other.

From the 20th of March to the 23d of September, the days are longer than the nights in all those places of the northern hemisphere of the Earth which revolve through the light and dark, and shorter in those of the southern hemisphere. From the 23d of September to the 20th of March, the reverse.

There are 24 meridian semicircles drawn on the globe, all meeting in its poles; and as one rotation or turn of the Earth on its axis is perfomed in 24 hours, each of these meridians is an hour distant from the other, in every parallel of latitude. Therefore, if you bring the annual index *h* to any given day of the year on the immoveable plate, you may see how long the day then is at any place of the Earth, by counting how many of these meridians are in the light, or before the crescent, in the parallel of latitude of that place; and this number being subtracted from 24 hours, will leave remaining the length of the night. And if you turn the Earth round its axis, all those places will pass directly under the point of the solar ray, which the Sun passes vertically over on that day, because they are just as many degrees north or south of the equator as the Sun's declination is then from the equinoctial.

At the two equinoxes, *viz.*, on the 20th of March and 23d of September, the Sun is in the equinoctial, and consequently has no declination. On these days the solar ray points directly toward the equator, the Earth's poles lie under the inner edge of the crescent, or boundary of light and darkness; and, in every parallel of latitude, there are twelve of the meridians, or hour circles, before the crescent, and twelve behind it; which shews that the days and nights then are each twelve hours long at all places of the Earth. And if the Earth be turned round its axis, you will see that all places on it go equally through the light and the dark hemispheres.

On the 21st of June, the whole space within the north polar circle is enlightened, which is 23½ degrees from the pole, all around; because the Earth's axis then inclines 23½ degrees toward the Sun; but the whole space within the south polar circle is in the dark; and the solar ray points toward the tropic of Cancer on the Earth, which is 23½ degrees north from the equator.—On the 20th of December the reverse happens, and the solar ray points toward the tropic of Capricorn, which is 23½ degrees south from the equator.

If you bring the annual index *h* to the beginning of January, and turn the Moon's orbit S T by its supporting wires Q and R till the ascending node (marked ☊) comes to its place in the ecliptic O P, as found by an Ephemeris, or by Astronomical Tables, for the beginning of any given year; and then move the annual index by means of the knob *n*, till the index comes to any given day of the year afterward, the nodes will stand against their places in the ecliptic on that day. And if you move the index onward, till either of the nodes comes directly against the point of the solar ray, the index will then be at the day of the year on which the Sun is in conjunction with that node. At the times of those new Moons which happen within seventeen days of the conjunction of the Sun with either of the nodes, the Sun will be eclipsed; and at the times of those full Moons, which happen within twelve days of either of these conjunctions, the Moon will be eclipsed. Without these limits there can be no eclipse either of the Sun or Moon; because, in nature, the Moon's latitude, or declination from the ecliptic, is too great for the Moon's shadow to fall on any part of the Earth, or for the Earth's shadow to touch the Moon.

Bring the annual index to the beginning of January, and set the Moon's apogeal wire U U to its place in the ecliptic for that time, as found by Astronomical Tables; then move the index forward to any given day of the year, and the wire will point on the small

ecliptic to the place of the Moon's apogee for that time.

The Earth's axis *f* inclines always toward the beginning of the sign Cancer on the small ecliptic O P. And if you set either of the Moon's nodes, and her apogeal wire, to the beginning of that sign, and turn the plate A about, until the Earth's axis inclines toward any side of the room (suppose the north side) and then move the annual index round and round the immoveable plate A, according to the order of the months and signs upon it, you will see that the Earth's axis and beginning of Cancer will still keep toward the same side of the room, without the least deviation from it; but the nodes of the Moon's orbit S T will turn progressively towards all the sides of the room, contrary to the order of signs in the small ecliptic O P, or from east, by south, to west, and so on; and the apogeal wire U U will move the contrary way to the motion of the nodes, or according to the order of the signs in the small ecliptic, from west, by south, to east, and so on quite round. A clear proof that the wheel F, which governs the Earth's axis and the small ecliptic, does not turn any way round its own centre; that the wheel G, which governs the Moon's orbit O P, turns round its own centre backward, or contrary both to the motion of the frame B C and thick wheel E; and that the wheel H, which governs the Moon's apogeal wire U U, turns round its own centre, forward, or in direction both of the motion of the frame, and of the thick wheel E, by which the three wheels F, G, and H, are affected.

The wheels D, E, and F, have each 39 teeth in the machine; the wheel G has 37, and H 44; as shewn in *fig.* 3.

The parallelism of the Earth's axis is perfect in this machine; the motion of the apogee very nearly so; the motion of the nodes not quite so near the truth, though they will not vary sensibly therefrom in one year. But they cannot be brought nearer, unless larger wheels, with higher numbers of teeth, are used.

In nature, the Moon's apogee goes quite round the ecliptic in eight years and 312 days, in the direction of the Earth's annual motion; and the nodes go round the ecliptic, in a contrary direction, in eighteen years and 225 days. In the machine, the apogee goes round the ecliptic O P in eight years and four-fifths of a year, and the nodes in eighteen years and a half.

Notwithstanding the difference of the numbers of teeth in the wheels F, G, and H, and their being all of equal diameters, they take *tolerably well into* the teeth of the thick wheel E, because they are made of soft wood. But if they were made of metal, the wheel E in *fig.* 1 ought to be made of the shape of E (seen edgewise) in *fig.* 3, with very deep teeth; and the wheels F, G, and H, in *fig.* 1, of diameters proportioned to their respective numbers of teeth, as F, G, and H in *fig.* 3. And then the teeth of these three wheels would be of equal sizes with those of the wheel E wherein they work, and the motions would be free and easy, without any pinching or shake in the teeth.

LE ROY'S PRIZE CHRONOMETER,

WITH A MEMOIR ON THE BEST METHOD OF MEASURING TIME AT SEA.

To the Editor of the Horological Journal.

Sir,—This extract from Tilloch's Philosophical Magazine for 1806, containing an interesting account of the Prize Chronometer made by Le Roy for the King of France, I have much pleasure in communicating. Your obedient servant,

34, Great Ormond Street. Theo. Gordon.

A Memoir on the best method of measuring Time at Sea, which obtained the double Prize adjudged by the Royal Academy of Sciences, containing the Description of the Longitude Watch presented to His Majesty, the 5th of August,* 1776. *By* M. Le Roy, *Clock-maker to the King.*†

Translated from the French by Mr. T. S. Evans, F.L.S., of the Royal Military Academy, Woolwich.

"A great deal has lately been said on the subject of chronometers, more especially with regard to what is contained in the description given by M. Le Roy of his timekeeper; and the work to which that description is subjoined being now in the hands of very few persons, the Translator thought this paper in English might be a valuable addition to the very little useful matter which we possess on that branch of mechanics. It has been asserted, that the greater part of the improvements in chronometers lately laid before the Board of Longitude are mentioned in this account of Le Roy's; the public will therefore now have it in their power to judge for themselves. T. S. E."

——"Labor omnia vincit
Improbus." Virg. *Georg.* lib. i.

* Louis XV., King of France.

† This Memoir is subjoined to the "*Voyage fait par ordre du Roi en* 1768, *pour éprouver les montres marines inventés par M. Le Roy*; M. Cassini, *fils*." Paris, 1770, 4to.

INTRODUCTION.

By proposing to determine the best method of measuring time at sea, the Academy appears to require, first, such a measure of time as may give to mariners the knowledge of the longitude, which has been so much desired, that for many ages it has been the principal object of their researches, as well as of astronomers and philosophers of the greatest celebrity. In the second place, by the expression "to determine" the Academy appears to require also palpable proofs that the method proposed is the best possible.

To comply with these requests, I shall divide this Memoir into four parts.

In the first I shall go through the different methods hitherto attempted, or which can be hereafter tried, for measuring time at sea; I shall make known the insufficiency of most of these methods; and I shall show that, notwithstanding the irregularities of our portable watches, we are thoroughly persuaded that the best means of obtaining the desired measure of time consists in a kind of perfected watch.

In the second part I will endeavour to point out all these irregularities, and to discover the different causes, physical or mechanical, whence they are derived, in order to be more in a state to correct them afterwards.

The third shall contain the description of a chronometer, or kind of large watch, deposited with this Memoir. I shall show that by its construction it is exempt from the defects remarked in common watches, and I shall enter into the detail of the expedients which have been used in the workmanship to prevent them.

Lastly, I shall terminate this memoir by a recapitulation or suite of observations, forming so many parallels to the methods which I have employed, with those that may be made use of with the same view. I hope to prove, by experiments and palpable reasonings, that mine must obtain the preference. If I succeed, I shall be well paid for twenty years consumed in these researches, since, besides the honour of being crowned by the Academy of Sciences, this discovery concerns the good of humanity, and even the preservation of a number of lives. If, on the contrary, my labour is without success, there will remain at least the satisfaction of having spared no pains or expense in endeavouring to fulfil the honourable task imposed upon me as a man, a patriot, and an artist.

PART I.

Examination of different methods which may be tried to measure time at sea.

Moving bodies being evidently the only measures of duration of time,* that nothing may be omitted on so important a subject, let us first cast our eyes on those whose motions may appear capable of giving an exact measure of time.

The first which present themselves are the stars. The perfection to which telescopes have been carried, the successful labours of many celebrated astronomers in the theory of Jupiter's satellites, and the tables which they have given of their revolutions,† give us reason to believe that they will presently come to be of very great help for measuring time at sea: the same must be said of the theory of the Moon.

But when we shall have given to these tables and these telescopes all the perfection that can be desired, we shall find that they are yet insufficient. We cannot always see the Moon, still less the satellites of Jupiter: supposing, even, that we could observe them as often as circumstances require, these observations are in some degree useless, without an instrument that would preserve the hour with exactness after we have determined it by the sun.‡

The observations of the heavenly bodies cannot, therefore, entirely fulfil our wishes: let us therefore look among the bodies which are more at hand, if there be not some one which by motions arising from different causes would be proper to give us the required measure of time. Those which offer themselves first to our examination are fluids, and solids reduced into insensibly small parts, forming clepsydras and sand-glasses; bodies falling, or making oscillations by their gravity combined with their inertia; the vibrations of magnetic bodies; and those which solids make by the help of an elastic force, &c. By reflecting we shall presently find, that of all bodies in motion there are only the latter which can with any exactness measure time at sea.

It appears, first, that all bodies, whether fluid or solid, moving by the effect of their gravity are by that alone inadmissible in the present case. Besides that their motion will be always more or less accelerated or retarded by the shocks that they will receive from the ship, we know also that their gravity is variable under different parallels; it is therefore not probable that we can ever correct this source of irregularities.

I know of no other person except Sully,* who in his marine or lever clock has pretend-

* Le Monnier, *Institutions Astronomiques*, p 157.

† See the Essay on the Theory of Jupiter's Satellites by M. Bailly; and Jeaurat's Tables.

‡ This remark is M. Daniel Bernouilli's, p. 21 of his *Recherches Mechan. et Astron. sur la meilleure manière de trouver l'heure en mer, &c.*

* See the machines approved by the Academy of Sciences, and the author's abridged description.

ed to have obviated them on this principle, that by adding proportionally weight to the balance and to the lever, the rate of the clock would not be changed; but the Academy, in approving the efforts of this artist, declares in its report that it does not adopt all his reasonings. Nothing can be more deceitful in effect than that on which he founded this pretended property of his clock. To convince ourselves, let us remark, that the vibrations of his regulator, like those of a pendulum, are produced by the force of inertia combined with that of gravity; that the first cause operates principally on the balance, whose gravity has no influence on the time of vibration; that the second resides in the lever, whose inertia has very little effect, because it descends almost vertically; and that, lastly, the time employed in each vibration depends on the proportion which exists between the balance and the lever, that is to say, the same as in the pendulum, the ratio of inertia to that of gravity.

The experiment which Sully† made before the Academy proves nothing. When by adding matter to his balance he augments its gravity, he makes also the force of inertia to increase in the same proportion; but under the pole, its gravity augmenting without its quantity of matter changing, its inertia would not experience any increase.

In heavy bodies in motion, to compensate the effect of their different gravity in various climates, (an effect which may go so far as to retard a seconds pendulum two minutes in twenty-four hours when removed from the parallel of Paris to the equator), it would be necessary to find an expedient by means of which their inertia should be proportioned always to the increase or alteration of their gravity; but, the force of inertia of bodies being a first and unalterable cause, this does not appear possible.

In vain would they pretend to estimate the difference we have just spoken of by keeping a register of the parallels under which they would navigate, and of the time which they would remain there. Besides all the difficulties of this method, and the very complicated calculations which it would require, it cannot be exact without a perfect homogeneity in the different parts of the earth, which homogeneity appears to be contradicted by the observations of the different lengths of the seconds pendulum made in different climates. It supposes, moreover, that the sailor can know, several times each day, at what height he is; which is a very strained supposition.

A long detail on this subject would be useless. We know sufficiently the defects of clepsydras and sand-glasses; we are not ignorant of the inconveniences of the circular-triangular pendulums &c. proposed by M. Huygens, or of those coupled together by wheels acting in each other, like those tried by the late M. Dutertre.* Experience has sufficiently shown the defects of these methods and of many others, which for this reason I shall pass by in silence.

I come now to bodies which make vibrations by their inertia combined with that universal force which directs the needle of a compass.

The celebrated Dr. Hooke† thought that we might apply it advantageously to a clock in the quality of a regulator. But Graham, having observed at different times, and during the same interval of time, the number of vibrations of the needle of a compass made and suspended on a pivot with the greatest care, found that it was not always constant.

I have observed also, by means of an instrument which I call a magnimeter, which by a long index marks on a limb the variations of magnetism, first, that this force in a body changes according as it is well or ill placed in the direction of the magnetic meridian, according as it is more or less elevated in the atmosphere, and according to the different degrees of heat and cold. I have, besides, observed that thunder produces sensible variations in these forces, and that in the aurora borealis there happen also considerable changes, as they have observed in Sweden. I only mention these experiments, the detail of which would draw me too much aside from my subject: I hope some day to give an account of them to the Academy.

There now remain only the bodies in vibration by the help of the elastic force. Every thing induces us to presume that these are the most proper to procure the required measure of time. The regularity of certain watches which are executed daily, but, above all, the trials that have been made with the timekeepers of the celebrated Mr. Harrison, the recompence that he merits for them, confirm, in some degree, what was before only a presumption, and appear to demonstrate that the true, and perhaps the only means of measuring time exactly at sea, consists, as we have before observed, in the perfected watch. But as watches in general are very distant from the precision requisite in a marine watch, we should first search out their different irregu-

† Abridged Description. p. 7. In this experiment Sully attempted to prove that the unequal gravity of bodies in different latitudes produces no change in the *going of his machine.*—T. S. E.

* See Thiout, Traité de l'Horlogerie, pl. 39, fig. 5.—T. S. E.

† Philosophical Transactions.

larities, and the causes, whether physical or mechanical, whence they are derived; according to the example of a wise physician, who, before he has recourse to a remedy, endeavours to understand the disorder well, and what may occasion it. This is what I shall do in the following part: in order to render the different objects which are treated of more evident, I shall make so many separate articles of them.

As mechanics is here continually intermixed with natural philosophy, whatever is only supported by reasoning, however solid it appears, will always be very uncertain. I have but too frequently found it so. Therefore I shall advance nothing of which I am not assured by facts, as the Commissioners may verify.

(To be continued.)

ACCELERATION OF RATE IN NEW CHRONOMETERS.

Mr. Editor,—All chronometer makers who have given the subject any consideration are perfectly aware of the error—if error it can be called—of the tendency of new chronometers to gain upon their rates. I cannot conceive it to be the intention of your Journal to request chronometer makers to come forward and give all their "opinions" to any one curious enough to ask, when many have paid very handsome sums of money to become initiated in the handicraft; and those that have not paid money have devoted half their life-time to become masters of the hidden mystery or secret properties of the balance spring.* True it is, that chronometers with soft balance springs will lose on their rates, and also chronometers with very hard springs will lose on their rates; and, strange to say, the harder the springs are left, the more they will lose. But this method of manipulation is not resorted to by makers of any eminence.

When Earnshaw had discovered how to isochronise his balance springs, he found, with cruel disappointment, his chronometers to lose on their rates. "This disappointment," he exclaims, "nearly broke my heart." What further to do he was long at a loss to determine; but, obstinate in the cause he had pursued, and resolving not to give it up but with life, perseverance came once more to his aid, and with still more unremitting study he discovered a method of making his balance springs in such a manner that his chronometers ultimately gained upon their rates. I need not state that the springs he used were not hardened and tempered in the now usual manner, but hard rolled steel wire turned up upon a block and blued; and, to overcome the losing tendency of these springs, he introduced a defect which made the chronometers he afterwards produced imperfect—they were not isochronous.

The present method of hardening and tempering balance springs requires the greatest amount of skill a chronometer maker can possess; and if the operation is carefully performed, the gaining on the rate can be confined within very narrow limits. The balance spring is composed of very minute particles. In the process of hardening, the outside is of course hardened first, and the inside is cooled more slowly. The outside being first cooled, contracts into the interior, and thus binds its particles together in a condition unnatural to them; on the other hand, the particles of the interior being more slowly cooled, retain their elasticity, and are prepared to set themselves free when anything impairs the amount of rigidity of the outside particles or laminæ of the spring. This amount of rigidity will wear off by a few months vibration in the chronometer, during which time the chronometer will continue to gain upon its rate, until such time as all the particles of the spring have settled down to the required amount of tension. This I cannot consider to be a defect, provided the operation of making the spring is carefully performed, otherwise it becomes a matter of great importance; at the same time it is perfectly in the power of a skilful chronometer maker to overcome the supposed error almost to any extent he pleases.

There is also this fact: no one will purchase a new chronometer that has a tendency to lose on its rate; for when once a chronometer begins to lose on its rate, the longer it goes the more it will do so, showing that the spring has lost its elasticity, or is so badly made that the perfectness of form is not retained, the spring thereby becoming useless in a chronometrical point of view. In the perfect manipulation of the balance spring great skill is required, in the selection of the material, the important method of hardening and tempering, and science in its application.

As I am writing upon the subject, I think I may be permitted to state the following fact by way of illustration. My chronometer No. 130 was deposited at Greenwich on trial last year, and was returned as not having performed within the required limits, it having increased its weekly rate from 12·5

* Our Journal is "intended" as a repository of information. We do not believe in trade secrets.—Ed. H. J.

seconds to 60·2 sec., gaining 47·7 sec. the last week of the trial more than the first week. Seeing how close it was in compensation, and knowing it could not gain so much a second year, I was not disappointed at the result of the performance; but, had the chronometer shown a tendency to lose on its rate during the trial, I should have thrown away the balance spring in disgust. The rate of my chronometer was closed, and it was a second time deposited for trial. I am now in a position to state, the chronometer has been purchased from me by the Board of Admiralty, and consequently it has performed within the required limits; thus showing that the chronometer has settled down to a steady rate, after gaining rapidly during the first twelve months. The chronometer has been going now nearly two years: it was quite new when deposited for the first trial at Greenwich. I am, Sir, your obedient servant,

W. B. Crisp.

81, St. John-street-road.

[Whatever may be the "opinion" of our correspondent, *we* cannot but regard *any* variation from a uniform rate as a defect to be remedied by more extended knowledge and more practical experience.—Ed. H. J.]

ON THE TEMPERING AND SOFTENING OF STEEL.

(*From the* Revue Chronométrique, *June* 1859.)

A New Method of Tempering and Softening Steel; preserving from all Oxidation and Alteration the Surface of the Metal, which remains in its original state.

Tempering.—The inconvenience attending the method generally employed in tempering delicate pieces has suggested the following proceeding, which offers the advantage of heating the steel equally without oxidizing it.

The piece to be tempered is placed in a neutral gaseous atmosphere, shut up in such a manner that the metal cannot come in contact with the external air. It is thus isolated from the oxygen (the cause of oxidation), and all its parts acquire simultaneously the same temperature, owing to the extreme mobility of the gaseous molecules. Amongst the great number of gases which may serve for this operation, hydrogen and oxide of carbon appear to us preferable, on account of the facility with which they are obtained pure. However, both require precaution in their use—hydrogen, because it forms with *the air explosive* combinations which detonate very violently on the approach of a body in combustion; oxide of carbon, on account of those pernicious properties which make it one of the most powerful poisons, the more to be feared that its presence is not revealed by any special character.

The manner of working which approaches nearest to the theoretical conditions is the following:—

Let us suppose it is required to temper a cylindrical spiral spring. It is placed in a tube of very hard glass (green glass), isolating it from the walls (or sides) of the tube, the ends of the tube being drawn out by the lamp, which allows the closing up to be more slowly and easily effected, a current of hydrogen is passed through it, until it is certain that the air which it contained is driven out; the tube is then closed up (at either end) with the lamp, and afterwards heated in a hot bath of some kind up to the temperature suitable for the temper; the tube is then taken out by the upper part and plunged in a temper bath, where it breaks, leaving the piece in contact with the liquid.

We have neglected, in the preceding explanation, to point out two precautions which it is necessary to take: 1st, The vial must be furnished, as much on the interior as on the exterior, with tin-foil, and only the part where the fracture ought to take place left bare; 2ndly, At the moment of shutting the temperature should be raised, so that the gas may acquire a part of the expansion which it ought to have at the time of the tempering.

Another mode of operation necessitates the apparatus which we are about to describe:—The piece to be tempered is shut up in a porcelain pillar, crossing from top to bottom a crucible filled with coal or sand, its upper orifice being supported against the cover cemented to the crucible. The upper part shut up in the crucible is placed in a furnace, whilst the lower part is plunged into the temper bath, which ought to be sufficiently far off in order that the water may not give a perceptible vapour, which might spoil the result by spotting the steel. The operation is conducted in the following manner:—The piece to be tempered being shut up in the porcelain column, and maintained to the height of the crucible by a peg (shank or stock) going through the button of the cover, a current of hydrogen is brought in by the lower part of the porcelain column: (we shall see presently how it is produced.) This current drives out the air by the opening of the button of the cover, or by any other opening contrived for that purpose. When the air is entirely expelled, the temperature

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WHAT IS HOROLOGY?

(Continued from page 7.)

Mudge's Improvements in Timekeepers.

In *fig.* 37, *a* is a cock in which the upper pivot of the upper pallet runs, and *b* that which supports the lower pivot of the lower pallet; *c* is the cock on the nose of the potence on which both those pivots run, which are near the pivot of the balance wheel; *d* is the cock for one of the balance wheel pivots, and *e* the cock for the lower balance pivot: *f* is the potence screwed to the under side of the upper plate and carrying the small cocks (all the pivot holes in which are jewelled) nearly in the same relative positions in which they stand in the figure; the vertical hollow in *c* is to admit the arbors of the pallets.

Fig. 37.

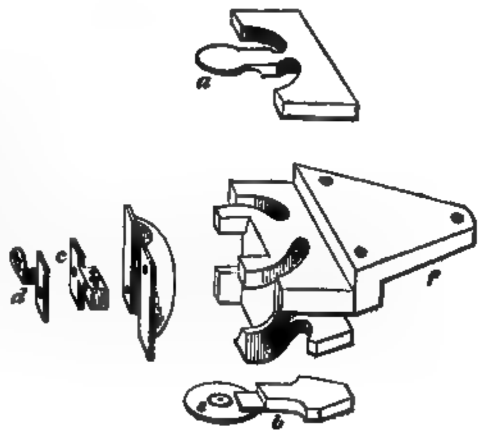


Fig. 38.

Fig. 38 is a perspective view of the escapement on an enlarged scale. A B is the balance, and E F its verge, shaped like a crank, of which the pivots I and K run in two systems of rollers set in little frames, one of which has already been described under *fig.* 34. One of the crosses of the balance bears a piece, *m*, to counterpoise the crank of the verge. C is the stud of the regulating spring placed on the cock of the balance, and D is the stud of the compensation spring screwed to the upper plate of the frame. The two springs are both attached by their interior ends to the upper part of the verge above the crank. The verge is shaped like a crank in order to free the small cocks just described with their appurtenances. A pin, *a*, projects from the upper bend of the crank verge, and meets another larger pin, *b*, made fast to the arbor of the upper pallet, which is shewn a little curved between *c* and *d*. This pallet arbor has the upper auxiliary spring fitted to it by

its interior end, the outer end being pinned to the stud at H. G is the pallet wheel, or what would now be called the balance wheel or escape wheel. There is another pin, *e*, at the bottom of the crank, similar to *a* above, and also a second pallet arbor, *g h*, carrying another pin *f*, and a second auxiliary spring, the outer end of which is pinned into the stud I; the helix of this spring being wound in a contrary direction to that of the upper auxiliary spring.

The action is as follows:—When all is at rest, the crank verge and the piece on the two bends of it are so adjusted as to rest quietly against the pins *b* and *f* of the pallet arbors. The two pallets are also at liberty, one remaining in the space diametrically opposite the acting tooth which rests against the other. If now the balance-wheel be impelled forward, it pushes against one of the pallets—say the upper one, which resists it through the action of the auxiliary spring upon its arbor. The power of the mainspring applied through the train of wheels is sufficient to turn the pallet round, and so wind up the auxiliary spring, till the tooth of the balance-wheel sliding on the concave side of the pallet is stopped by the little hook at its extremity, which now acts as a detent and arrests the further motion of the escape wheel, the amount of angular motion of the pallet being about 27 degrees. If now an external impulse be given to the balance, sufficient to make it moves through a semi-vibration of about 120 degrees, the pin *a* of the crank catches the pin *b* of the pallet arbor, and consequently disengages the pallet, and goes on winding up the auxiliary spring during the remainder of the vibration. The balance-wheel in the mean time runs on, being disengaged from the upper pallet, till it arrives at the hook of the lower pallet. During this motion it has no connection with the balance, therefore the escapement is a detached one; that is, the balance vibrates freely without connexion with the wheel-work. The balance being detained by the bend at the extremity of the lower pallet, the pin *f* in the latter has been moved from the place of rest, and is ready to be caught by the pin *e* in the lower bend of the crank verge. The balance now returns from the extremity of its vibration, and is impelled by the pin *b*, acting against the pin *a* of the crank during the whole semi-vibration, so that it is itself impelled more than it impels the pin, and the difference of the continuation of the two impulses constitutes the impulse available for continuing the motion of the balance. The balance crank on its return, in passing the point of original quiescence, has done with the spring of the upper pallet, which now remains in its first position; the pin *e* then meets the pin *f* of the lower pallet arbor, which is in its turn impelled by the said pin as in the former case, the upper pallet being again carried forward by the next following tooth of the wheel. When this second semi-vibration is complete, the balance returns, driven by the pin *f* to the point of its spring's quiescence as before; and thus the process is carried on. Some of the balance or escape wheels were made of tempered steel, and some of brass, and the acting portions of the pallets were jewelled. The two slender springs within the crank are called *auxiliary* springs, because they act with the other two springs in the returning part of each vibration, although their force is not more than one-twentieth of that of the primary spring.

We have been thus minute in our description of Mudge's escapement as giving a fair specimen of the principles of action of remontoire escapements generally. It may be well here to remark that, at any rate in the smaller description of timekeepers, this principle of construction has not been found to answer expectation. The necessarily increased complication of parts involves the introduction of an increased number of sources of error, which of course decreases the chances of success; added to which the disturbing effect of temperature on the delicate remontoire springs goes to make up a sum total of disadvantages which has led to the abandonment of remontoire escapements for chronometers and pocket watches. An immense amount of ingenuity has, however, been exhibited in the contrivance of escapements of this class, and it will be profitable, and indeed necessary, in our epitome of the history of Horology, to describe a few of these examples of skill in the proper place.

(To be continued.)

Westminster Clock. — On Wednesday morning (14th September) the quarter-chime bells of the great clock sent forth their sonorous peals, which were continued every quarter of an hour during the day. The bells have as yet an extremely dull sound, which is attributed to the scaffolding around the belfry in the clock tower not having been removed. Workmen suspended in a large box from a massive derrick, that projected from the open work above the clock, were engaged in affixing the hands, and at five o'clock had succeeded in completing the eastern dial. The first stroke on the great bell, and not the quarter chimes, indicates the hour by Greenwich mean time. The chimes at the first, second, and third quarters begin to strike at those times respectively. Persons hearing the clock at long distances must remember that sound takes 4½ seconds to travel a mile.

LE ROY'S PRIZE CHRONOMETER,

WITH A MEMOIR ON THE BEST METHOD OF MEASURING TIME AT SEA.

(*Continued from page* 13.)

PART II.

Examination of the Causes which make Watches vary.

Article 1.

Of the Spring in general, and of the Alterations which may happen in the force of the Spiral Spring.

The first question which presents itself to be cleared up in treating of the theory of watches, and which however appears to be made for the first time, is this: Is the spring in itself, abstracting from the effects of heat, a constant power, on which we may establish a principle of perfect regularity, or is it not?

Those axioms of the philosophers, that there is no perfect spring in nature; that it does not admit of any precision, &c., would appear at first to announce in the spring a power not very proper to give the required accuracy in a marine clock. But, on the other hand, many philosophers and artists think that the spring is a constant power when it is but little contracted.

To have more exact notions on this subject, I have constructed an instrument, *fig.* 1,

Fig. 1.

and I call it the *elaterometer.* This is in some degree only a long spring, *r r*, stretched by a weight *p*, which, according as the force of this spring increases or diminishes, ascends or descends, the distance that it moves being rendered a hundred times more sensible by means of a long index *l l*, whose weight on the spring is insensible, this weight being counterbalanced by an opposite branch *b l*, which makes it almost in equilibrium.

By means of this instrument we find that the spring loses a considerable part of its force in the first month of its tension; that then the loss is much less; that at last it becomes almost insensible, unless the spring receives a considerable degree of heat, for then the index falls several degrees; and when the thermometer returns to the degree where it was before, this index does not ascend to the same point, but rests below. These experiments appear to show that the vibrations of the spiral spring can measure time but imperfectly; but here follow several considerations that must convince us of the contrary: 1st. In the vibrations of this spring, its contraction and opening are only momentaneous: 2dly, By supposing that in its contraction, for example, it had been bent a little, it would return presently to its proper opening. But even when it experiences some loss on one side, this cannot be done without its gaining it on the other, as daily experience proves. There would result, therefore, from this a compensation. All the inconvenience that would follow is, that the watch will not be so perfectly adjusted in its escapement. Lastly, the experience of watches with dead escapements* confirms again what I have advanced. The greater part, after having gone for several years, are still found to be regulated when they have been cleaned, if there has been no considerable wear in the parts of their escapements. These observations show, nevertheless, that we cannot take too much pains for the spiral spring to be fastened in a natural and unconstrained situation† (as recommended by Daniel Bernoulli). This is what does not take place in most watches, and it is (as we shall see in the end) that which I have particularly endeavoured to execute.

We must conclude also from what precedes, that nothing would be more disadvantageous in watches than two spiral springs in contraction, as John Bernoulli has proposed‡; for then the effects observed by our elaterometer would absolutely take place.

Besides, a very simple reasoning suffices to convince us that there is not in nature any spring which is not in the case of the constrained equilibrium (*l'equilibre forcé*) recommended by M. Bernoulli.‡

* Echappements à repos. See Berthoud, *Traité des Hor. Marines*, p. 316, § 969; and *Essai sur l'Hor.*, tom. ii. 1642.—T. S. E.

† Recherches Mechaniques et Astronomiques, p. 45.

‡ Recherches Physiques sur la Propagation de la Lumière. We may consult also on this subject D'Alembert's *Opuscules Mathematiques*, tom. v., p. 503. In the piece which obtained the prize of the Royal Academy of Sciences for 1736, M. Bernoulli shewed several things analogous to the spiral springs that are applied to watches. He recommends to attach two of them to the centre of the balance, whose spires turn in a contrary direction, to have what he calls a centre of constrained equilibrium. He pretends to remedy

a spiral spring is analogous to the wire of a harpsichord; when either of them vibrates, it is always a mass moved freely by an elastic force:" therefore, they conclude, "the balance, assisted by the spring, makes its reciprocations, more or less wide, in times that are perfectly equal,"

This reasoning proves, moreover, that all the vibrations of a springing body are nearly isochronous, the ear not being sufficiently delicate to perceive the small differences in the tones. Besides, M. de Mondonville has found that the tone of a chord rises more or less according to the degree of force which presses it, and that this goes as far as a semitone, when it is done very softly, although the graduation observed in swelling and softening the sound commonly renders this difference insensible to the ear.*

Something more precise is therefore necessary to know exactly whether (allowing for friction, for the resistance of the air, &c., circumstances to which we shall attend further on) the vibrations of the spiral spring connected with the balance are isochronous, or whether they differ in time according as they are more or less extended.

We know, by the theory of forces, that the different excursions of a moveable body are isochronous, when those which push them are in the ratio of the distance of the term to which they make it bend. The true method of clearing up the present question appears therefore to be, to examine, by experiment, whether the force of spiral springs augments according to the proportion of the spaces described in their different contractions or their different openings.

To know what we are to think on this capital point, I took the mainspring of a common watch and attached its interior extremity to an arbor sustained by very fine pivots, which carried a large pulley: I then fixed the exterior end of this spring to a fixed point, so that it might rest in its natural state. This done, I fixed a wire to the pulley, and wound it round; then I fixed to the other end of this wire a small hook, on which I placed successively different weights, these weights bending the spring in opening and shutting it more than if it had caused a balance to vibrate; I observed the ratio in which the hook descended, and I found it always as the weight with which it was charged.† If, for example, half an ounce made it descend a certain quantity, an ounce made it descend a double quantity, and so on.

Indeed it was not the same when the arbor had made several turns; the spaces described then no longer augmented in proportion to the weights; [this difference very sensible on the side where the spring shut, became almost nothing on the side where it opened; this is why I attribute it, in a great measure, to the change of the lever by which it acted.

However it may be, as the ratio of the weights take place in our experiments for arcs much greater than those which the balances of watches describe, it appears that we should be in the right to conclude that its vibrations are exactly isochronous; that, consequently, the inequalities of the motive force, those which arise from losses of freedom in the wheel-work, &c., become nearly compensated in watches having a dead escapement: but this is what does not take place.

In all the experiments that I have made on the duration of the vibrations of their regulators, making oscillations either by the action of the wheel-work, or freely and independently of this action, I have almost always found, as well as the most celebrated artists and men of science,* that the long vibrations were always slower than the short: I have even remarked that in a double arc the difference was most frequently $\frac{1}{120}$. This effect arises, I believe, from the mass of the spring, or perhaps from the obstacles which it experiences internally† to display its strength.

It is only lately that I have at last found, as I shall explain more particularly, what is very important, and which besides must serve as a base to the theory of watches, and a guide to workmen who construct them, viz., that there is in every spring of sufficient extent a certain length where all the vibrations, long

* Mr. Ferrein's "Dissertation on the Formation of the Voice," in the Memoirs of the Academy of Sciences for 1741.

† Dr. Hooke discovered this many years before, and made it the subject of an anagram, which Dr. Wallis found to be *Ut tensio sic vis.*—T. S. E.

* This is shewn in the writings hitherto given on Clock-work. See M. Sully's Dissertation on his Marine Watch (4to, 1726, Paris); *Les Etrennes Chronometriques* of M. Le Roy, p. 69, &c. The attempts made by several artists to correct this retardation prove it also; witness the compensation curb of M. Gourdain adapted to the spiral spring. The report made to the Board of Longitude who examined Mr. Harrison's Timekeeper, shews that the English artists are of the same opinion. See the *Gazette du Commerce* for the year 1765, Tuesday, October 8; and the Report, signed Ludlam, sent to the Academy. "The principle, says this report, on which Mr. Harrison forms the third change is, that the long vibrations of a balance, whose motion is caused by the same spring, are made in less time. This principle is contrary to all the opinions received among men of science, workmen, &c."

† See vol. iii., p. 97, John Bernoulli's Works.—T. S. E.

or short, are isochronous; that this length being found, if you shorten the spring, the long vibrations are quicker than the short ones; if on the contrary, you lengthen it, the small arcs are described in less time than the large ones.* It is on this important property of the spring, hitherto unknown, that the regularity of my marine watch particularly depends, as we shall see in the end. From what precedes we are sensible that the accuracy of watches depends, in a great measure, on the length given to the regulating or spiral spring.

If with the same kind of dead escapement certain watches go badly, whilst others are very regular, we here see the cause of it; and, moreover the new observation may be of great help in the disposition of pendulums, whether small or seconds, where the pendulum is suspended by a spring; in effect, we know by what precedes that it must have such a length in the spring of suspension, that all the vibrations of these pendulums may be isochronous. Though we should suppose, even in the regulating spring of a watch the length requisite to render all the vibrations of the balance isochronous, if it was applied there by the common methods, this isochronism would be presently destroyed by the friction of the pivots of the balance, which, according to the remark made by Daniel Bernoulli,† would become always less considerable in great arcs than in small; for, by theory, the obstacles of friction, the tenacity of oil, &c., as those of gravity, of springs, of cohesion, &c., are proportional to the times during which they are surmounted. Now, the vibrations independent of these frictions being supposed isochronous, these frictions must become much less considerable with regard to the force which surmounts them when, for example, these arcs are doubled; since this force, being as the arcs, is then doubled, and the time not sensibly different.

M. Sully has made experiments on this subject as decisive as they are curious, which may be consulted.‡

The inverse of what precedes takes place for the friction occasioned by the balance wheel on the parts of the escapement, viz., the cylinder in those of Graham, and on the plates or planes in those of Debaufre, Sully, Le Roy, Gourdain, &c. These frictions, instead of rendering the long vibrations quicker than the short ones, on the contrary augment the duration of the former: the following is the cause. The balance being supposed to have the necessary freedom, it is impossible to augment the arc without augmenting the force which supports the vibrations, and consequently the pressure of the balance wheel on the cylinders or planes, &c.; and as, by theory, a quadruple force is necessary (abstraction being made from a great number of causes, both physical and mechanical, which concur here to destroy a part of the motion of the balance)—as it is necessary, I say, to have a quadruple force to impress on the balance as well as on the balance wheel a double velocity, it follows, that the pressure on the cylinders, the planes, &c. (always in proportion to the motive force) augments here in a much greater ratio than the force of the regulator to overcome them, which is only as the velocity. We know, also, that when the wheel-work is impeded, whether by friction, the coagulation of the oil, &c., there must arise considerable variations in watches with a dead escapement, for then the force communicated to the balance is necessarily much less. But the friction on the cylinders or planes is not diminished by this, because the pressure of the wheel on these cylinders or planes is a dead force, and the resistance and friction of the wheel-work have no sensible effect, except when the moveable parts are in motion.

We can hardly determine any thing respecting those causes which affect the isochronism of the vibrations in watches with a dead escapement, and which, without any thing regular, make them advance or retard. All that we can say is, that they augment or diminish according to the quantity of friction on the cylindric portions, according to the form of the balance, the size of its pivots, the quality of the oil, the length of the spiral spring, the number of vibrations in a given time, the length of the arc, the points of that arc where the wheel ceases to act on the balance, the number of teeth in the balance wheel, its mass, the quantity of motive force, &c.

There are, without doubt, a number and a magnitude of vibrations where the effect of these different causes is least sensible; but what precedes has already proved to us, that the best way, without any comparison, will be always (as I shall hereafter demonstrate more positively) to give the vibrations of the balance the greatest freedom possible. This is what I have practised in my machines.

(*To be continued.*)

* The way in which he made this important discovery is related in the beginning of Article VIII., Part III.—T. S. E.

† Recherches Méchaniques et Astronomiques, &c., p. 41.

‡ Suite de la Description d'un Horloge, &c., p. 168; Dissert. sur un Montre Marine, &c.

ON THE WEIGHT AND DIAMETER OF THE BALANCE.

If the diameter of the balance is too great, any addition of motive force will make the watch go slow; if too little, the watch will go fast; and if of a proper weight and diameter, any addition of motive force will make little or no change on the time-keeping, whether the watch is hanging or lying. We have made the motive force more than double, and no change took place; the isochronism of the pendulum spring no doubt had its share in keeping up this uniformity. Balances, whose diameters are rather small, will have a natural tendency to cross farther; that is, the arcs of vibration will be greater than where the diameters are great. Their weight will be in the inverse ratio of the squares of their diameters; from which it follows, that if the balance is taken away from a watch which has been regulated, and another put in its place having the diameter only one-half of the former, before the watch could be regulated with the same pendulum spring, the balance would require to be four times heavier than the first. One way of estimating the force of a body in motion, is to multiply the mass by the velocity. Let us then calculate the respective forces of two balances, whose diameters are to one another as two to four. The radii in this case express the velocity. According to this principle, we shall have, for the small balance, two for the radius multiplied by eight of the mass, equal to sixteen; and for the great one, four of the radius by two of the mass, equal to eight. Sixteen and eight are then the products of the masses by the velocities, consequently they express the force at the centre of percussion of each balance; and as it is double in the small one, it is evident that the arcs of vibration will be greater, having the faculty of overcoming easily any resistance opposed to it by the pendulum spring, without requiring any additional motive force.

Let us take an example done in another way:—Which is the square of the product of the diameter, multiplied by the velocity or number of degrees in the vibration, and this again multiplied by the mass or weight, so as to compare the relative momentum of two balances of different diameters, &c. Suppose one balance to be ·8 of an inch in diameter, the degrees of vibration 240, and the weight 8 grains; the other ·7 of an inch in diameter, the arc of vibration 280°, and the weight 10 grains:

$$240 \times \cdot 8 = 192 \times 192 = 36864 \times 8 = 294912$$
$$280 \times \cdot 7 = 196 \times 196 = 38416 \times 10 = 384160$$

The balance having the smaller diameter has its momentum to that of the greater as 384160 is to 294912, or, in smaller numbers, as 99 is to 76 very nearly. When the arcs of vibration are great, the nearer to isochronism will the long and short ones be.

If the balance of a watch has its arms and centre part rather a little heavy as otherwise, and these be made less so, the watch by this will be found to go slower than it did before, owing to the effect of the increased momentum of the balance. This unusual, *perhaps hitherto untried and very delicate* experiment, we made once or twice, and the result was that which has now been stated. The momentum of a watch balance should be as nearly in one point of the rim as possible, and is somewhat analogous to that which is required in the ball of a clock pendulum.

Berthoud, in his *Essai*, &c. insists much on the advantage of light balances, great diameters, and quick vibrations; principles, however well dressed up as a theory, will be found not to agree with sound practice and a little experience. M. Jodin, a very ingenious watch-maker, contemporary with Berthoud, in Paris, knowing what Berthoud had advanced on this subject in his *Essai*, took an opportunity of putting him to rights, by using such arguments as ought in our humble opinion to have convinced him; but in this interview Jodin's endeavours were to no purpose. Berthoud, indeed, seems not to have acted in conformity with the principles he wished to establish, if we may judge by what he did, seeing that he made the trains of his marine timekeepers in such various numbers, from that of giving one vibration in a second to that of giving six in the same time; and the performance of one of those which gave one vibration in a second, is mentioned as having maintained the best rate of going of all that he had made. Mr. Cumming got also into the system of quick trains, but was obliged at last to give it up, and was in the end put to a considerable expense in altering every one of these his quick-trained watches, when he could lay his hands on them, because the cylinders were going so fast to ruin, that the watches gave no satisfaction.

It may be found very convenient, and sometimes of great utility, for the practical artist to have a little knowledge in the theory of the relative force of balances, according to their diameter, weight, and the number of vibrations given in a minute. An instance shall be given that tends in some degree to show this:—A small eight-day spring timepiece, of a size somewhat less than that of common spring clocks, which had a balance and a detached escapement; the train was

rather slow, being 5400, but with such a train the force of the main-spring had so much power over the balance, as to make the vibrations at times go so far as to unlock the detent a second time in the course of one and the same excursion; the vibration being thus carried to such an extreme, and when nearly at the end of it; although a tooth of the balance wheel had for a second time dropped on the face of the pallet, it had no force to impel it farther on, that of the pendulum spring was greater from being now so much bent up; on its unbending, the balance was made to return a very little way back, which brought the circular part of the pallet into contact with one of the balance-wheel teeth, and by this means the tooth was now allowed to pass freely on the roller or circular part of the pallet, which had the effect of stopping the motion of the balance, and consequently stopped the going of the time-piece. It would have been a very inconvenient matter, at this time, *as we shall suppose*, either to have made the train quicker, or to have got a main-spring of less force, as any one of the two ways would have brought the vibrations of the balance within a shorter compass. Now, what device must be fallen on, in order to lessen the arc of vibration, so as the balance shall not go so far as to make a second unlocking, keeping still the same train of wheels, and the same force of main-spring? There is only one way to do this, and that is by increasing the diameter of the balance, which will then require a stronger pendulum spring, and this will of course give a little more opposition to the impelling force of the balance-wheel teeth on the face of the pallet. If we suppose the diameter of the balance to be one inch, or, what is the same thing, 10 tenths of an inch, and, to increase it, the three mean time screws which were in the edge of the rim of the balance being brought out so far as to make the diameter one inch and a quarter, or 12·5 tenths of an inch; by this alteration the time-piece was found to lose an hour and a quarter in the 24 hours. It is evident that a stronger pendulum spring must then be applied, before the balance can be made to vibrate mean time, and that in the ratio of the squares of the diameter of the balances, the square of 10 is 100, and the square of 12·5 is 156·25, the difference between these numbers shows that a considerable difference will be required in the strength of the pendulum springs. The weight of the balance, including the three mean time screws, pendulum spring, and stud, balance arbor, and roller, was 137 grains.

How to remedy the converse of the preceding case should be very obvious, and to many it will appear unnecessary to say any thing about it. Yet there may be some few who may not so readily fall on it, and therefore one example in this way shall be given. Suppose the balance of a time-piece has its vibrations so short, that no good performance can be derived from it, notwithstanding the movement, the escapement, the main-spring, &c. are as correct as could be wished. The short vibrations must then arise from the balance being too large in diameter, and from having too strong a pendulum spring. Now, if a balance of the same weight, or nearly so, but less in diameter, and a weaker pendulum spring be applied, this will allow the vibrations of the balance to be carried to a greater extent, which was all that was required.—*Reid on Clock and Watch Making.*

Biographical Notices of Eminent Horologists.

Dr. ROBERT HOOKE.

The period which immediately succeeded the Restoration is remarkable for the great and rapid advancement of science in England. Amongst the eminent men who then stood forth boldly in the cause of scientific truth, the name of Dr. Robert Hooke, the assistant of Boyle in chemistry and of Wren in architecture, deservedly holds a high position. As the inventor of pendulum springs for watches, his memory has a special interest to horologists.

Hooke was born at Freshwater, Isle of Wight, 18th July, 1635. His father, who was curate of the parish, at first intended him for the ministry, but his son's frequent illness so interrupted his studies that all thought of making him a scholar was abandoned. Thus left to himself he soon showed an inclination for those pursuits by which he afterwards became so distinguished. While yet a child, he constructed and made a wooden clock; he also made a small model of a ship of war, with a contrivance to fire the guns as it sailed across a piece of water. After the death of his father, in 1648, having shown a great fancy for drawing, he was placed with the celebrated painter, Sir Peter Lely; but not being able to bear the smell of the oil colours, he left, and was taken into the house of the Rev. Dr. Busby, then head master of Westminster School, where he not only acquired Latin, Greek, and the oriental languages, but the elements of geometry and music. He left Westminster and entered Christ

Church College, Oxford, in 1653. Hooke's genius soon attracted the notice of Dr. Wallis, whom he frequently assisted in his chemical operations; and by him he was introduced to the Hon. Robert Boyle, who engaged Hooke as an assistant in the mechanical and philosophical works he was then employed on.

After about two years spent in close application to his favourite studies, his talents became so generally recognized as to gain him an introduction to the members of the Philosophical Club. Hooke, in his account of the proceedings of this club, states, "About 1655, before which time I knew little of them, divers experiments were suggested and tried, with various degrees of success, though no other account was taken of them but what particular persons did for the help of their own memories, so that many excellent things have been lost. Some few, by the kindness of their authors, have been since made public. Among these may be reckoned the Hon. Robert Boyle's Pneumatic Engine and Experiments, first printed in 1660; for in 1658-9 I contrived and perfected the Air-Pump for Mr. Boyle, having first seen a contrivance for that purpose made by Mr. Gratorix, which was too rude to perform any great matter."

During the years 1656, 7, 8, he invented the balance or pendulum spring, the following account of which is given from Hooke's own notes:—"About this time, having an opportunity of acquainting myself with astronomy by the kindness of Dr. Ward, I applied myself to the improving of the pendulum for such observations; and in the years 1656, 7, I contrived a way to continue the motion of the pendulum, so much commended by Ricciolus in his *Almagestum*. These trials succeeding to my wish made me farther think of improving it for finding the longitude; and the method I had made for myself in mechanical inventions quickly led me to the use of springs, instead of gravity, for making a body vibrate in any posture, whereupon I did, first in great and afterwards in smaller models, satisfy myself of the practicability of such an invention; and hoping to have made great advantage thereby, I acquainted divers of my friends, and particularly Mr. Boyle, that I was possessed of such an invention, and craved their assistance for improving the use of it to my advantage Immediately after his Majesty's restoration, Mr. Boyle was pleased to acquaint the Lord Brounker and Sir Robert Moray with it, who advised me to get a patent for the invention, and propounded many probable ways of making considerable advantage by it. To induce them to a belief of my performance, I *shewed a pocket watch* accommodated with a spring *applied to the arbor of the balance* to regulate the motion thereof; concealing the way I had for finding the longitude. This was so well approved that Sir Robert Moray drew me up the form of a patent, the principal part whereof, viz., the description of the watch, is his own handwriting, which I have yet by me; the discouragement I met with in the progress of this affair made me desist for that time." The insertion of a clause to which Hooke would not agree, to the effect that if any one made an improvement on his principles, they, and not Hooke, should have the benefit of the patent during the remainder of the term, caused the treaty to be repeatedly broken off; Hooke considering that it would be easy to vary the application of the principle so as to deprive him of his due reward. Five years elapsed from the first discovery of the principle to the time that this treaty was finally broken off, during which period several watches were made by Tompion under Hooke's supervision. The first watch to which Hooke applied the pendulum spring he presented to Bishop Wilkins about 1661.

With some it is a disputed point as to whether the author of the enigma, the solution of which is *Ut tensio sic vis*, or Huyghens first invented the pendulum spring; but, referring to the highest authority, we find in the tenth volume of the Philosophical Transactions of the Royal Society, that "M. Huyghens sent hither a letter, dated 30th January, 1674, acquainting us with an invention of his of very exact pocket watches, the nature and contrivance of which he imparted to us, as he used to do other inventions of his, in an anagram, which he soon after, in a letter of 20th February, explained to us by a full description; for which the Royal Society thought fit to return him thanks, yet so as to intimate to him that Mr. Hooke had *some years ago* invented a watch of the like contrivance." By what we have stated it appears that Hooke invented the pendulum spring about the year 1658. Huyghens was not only at London in 1663—1665, but at several other times, and being a member of the Royal Society had every opportunity of getting information of the inventions of the day; it is not improbable that he may have heard something about this invention of Hooke's, so that when the great mathematician returned to France, he set to work and ultimately successfully applied pendulum springs to watches without ever having seen Hooke's invention.

Montucla appears to be the only foreigner who allows the invention and application of the balance spiral spring to Dr. Hooke; he

states, in his *Histoire des Mathematiques*, "A detail of the inventions and of the new fancies of Dr. Hooke would be extremely prolix; readers must have recourse to his numerous writings, which will justify the eulogium we have just now made him. We shall here confine ourselves to a mark of his sagacity, it is the application of the spring to regulate the motion of watches. This invention, so fortunate, and which is ordinarily ascribed to Huyghens, appears to me to be legitimately claimed by Dr. Hooke."

Hooke took part in and wrote upon almost all the scientific questions of his time; Sir Isaac Newton styled him "The Considerer." On the institution of the Royal Society he became one of its fellows, was afterwards entrusted with the care of its Repository, and made Professor of Mechanics to that body. About the same period he was elected Professor of Geometry in Gresham College. After the fire of London, in 1666, he produced a model for rebuilding the city, which led to his appointment as City Surveyor, in which employment he attained affluence; but the mechanical sciences were still the favourite objects of his pursuit. It would fill a volume to enumerate all the works he wrote; refering to a few,—In 1660 he published a small tract "On the cause of the rising of water in slender glass pipes higher than in larger, and that in a certain proportion to their bores." This subject occasioned a debate in the Royal Society in April, 1661, when his explanation of that phenomenon gained him such esteem that on the 12th November following, on the motion of Sir R. Moray, he was appointed Curator of Experiments to the Society. How well he performed his office the journals of the Society give testimony by the number and variety of experiments therein recorded. In 1674 he published a book upon "The Motion of the Earth, from Observations;" and in the same year, "Animadversions on the First Part of the *Machina Cœlestis* of the famous astronomer Johannes Hevelius." In 1675 he published "A Description of Helioscopes and other Instruments made by him." In a postscript to this work Hooke complains of Henry Oldenburg for publishing in the Philosophical Transactions (1674) a description of a watch with a pendulum spring made by Huyghens, and omitting to state "that this invention was first found out by an Englishman and long since published to the world," and calls it "*unhandsome* proceeding." In 1677, upon the death of Oldenburg, he was elected Honorary Secretary to the Royal Society, and soon after published a work containing, besides observations of the comets of 1664, 1665, and 1667, a discourse on comets in general. Several of his papers were printed in the Philosophical Transactions; but the chief work published in his life-time was entitled "*Micrographia*, or Philosophical Descriptions of Minute Bodies, &c." In 1691 he was created M.D. by warrant from Archbishop Tillotson, but it does not appear that he was ever practically engaged in that profession.

Hooke's great mechanical genius found full scope in the construction of instruments to aid him in the study of astronomy. It would be impossible in our limited space to state the many and various subjects he investigated; his wonderful inventive faculty was so fertile that he was frequently in pursuit of numerous objects. When we consider the pendulum spring in connection with the chronometer, enabling the mariner to sail thousands of miles with accuracy and safety, making a measured highway of the ocean, we think we are justified in saying that it is one of the greatest inventions of any age. Horology is also indebted to Hooke for the invention of a machine for cutting the teeth of watch wheels; this was carried into France by Sully, and afterwards claimed as a French invention. The anchor escapement was designed by him; and the duplex originated from a double-balance watch invented by Hooke about 1675. We may here mention that there was a pendulum spring upon one of these balances, and the object of their being pitched together was *to prevent the effect of external motion on them*, while it served the double purpose of bringing alternately about the pallets, and still gave some little *recoil* to the wheels by the reaction of the balances. He contrived the Circulating Pendulum, for the purpose of illustrating the motion of the planets, and for measuring small portions of time. He also invented the Universal Joint. With this coupling, rotary motion in shafts may be continued, though out of straight line with each other.

Hooke seems to have been of a restless disposition; with him age brought an increased desire for new discoveries. In fact, we may say his whole life was devoted to the advancement of scientific and practical knowledge; no sooner was he satisfied of the feasibility of any project, than he left it, thus leaving to others the perfecting of his discoveries. By an order of the Royal Society he was requested to give a full description of all the instruments which he had contrived, but ill health prevented him from performing it. During the last year of his life he was almost helpless. He died at Gresham College, 3d March, 1703, and was buried at St. Helen's, Bishopsgate. All the fellows of the Royal Society

then in London attended his funeral, thus performing the last office of respect to him they so much esteemed in life. His posthumous works appeared in 1705.

We have briefly run over his life—perhaps too briefly. We do not write in fancy hues when we say, that whenever the name of Dr. Robert Hooke is uttered, in ages yet to come, the memory of a great man will be recalled—a name to which Horology is much indebted.

THE SIZE OF PINIONS.

To the Editor of the Horological Journal.

Sir,—It was with much pleasure I read the article on the "Pitchings of Wheels and Pinions," by Thomas Reid, in your 12th number, and consider it one of the best that has appeared for the benefit and instruction of the working watchmaker; and if the subject could be illustrated by diagrams, showing what is meant by the line of centre action, also a good-formed tooth and leaf of pinion, it would be of much advantage.

The following Table recommended by F. Berthoud on the method of sizing pinions I think worthy of a place in the Journal:—

The full or acting Diameter of the Pinion.

No. of Teeth.	
4	Two full teeth of the wheel unrounded and the space between
5	Three teeth rounded from point to point
6	Three full teeth unrounded
7	Three full teeth and a quarter of a space beyond
8	Four teeth rounded from point to point
9	Somewhat less than four full teeth
10	Four full teeth
12	Five full teeth
14	Six teeth rounded from point to point
15	Six full teeth.

It will be seen from the above table, that there are some differences between the methods recommended by Reid and Berthoud; and what I wish to notice here is, that in the ordinary run of English lever watchwork, the pinions 7, 8, and 12, when well formed, will make a decidedly better action on Berthoud's method than Reid's; and although in the pinion 10, they both give the same measure, yet I find many movement makers make the centre pinion of 10 always larger than four full teeth, and good actions are to be obtained with them; upon what principle the movement makers work in sizing pinions, I should be glad to learn. Your's obediently,

September 20th, 1859. C——Y.

GREAT BELLS.

To the Editor of the Horological Journal.

Sir,—We have observed a great deal of clatter of late about the weight and sound of great bells, but it does not appear that we have a great deal to boast of when we contemplate the dimensions of the monsters abroad.

The great bell at Moscow weighs 432,000 pounds—almost enough to swallow up all the rest in Europe; and the one at St. Peter's in Rome, that was re-cast in the year 1785, is 18,667 pounds; another, that approaches nearer to the great bells in England, is placed in the tower of the Palazzo Vecchio in Florence, and is 275 feet from the ground, weighing 17,000 pounds, and supposed to be the finest-toned in the world.

In England we have, first in rotation, the Great Tom of Oxford, 17,000 pounds, and the next great one, of Exeter, weighing 12,500 pounds; and then follows the great bell at Lincoln—another Great Tom—that weighs 9894 pounds, while the great bell at St. Paul's only weighs 8400 pounds.

There are many places in England celebrated for their peals of bells; one of which is in the steeple of Saint Peter's at Nottingham, the seventh of which was given to the church by Margery Doubleday, a washerwoman, in 1544, with twenty shillings per annum to the sexton for ringing it every morning at four o'clock, in order to rouse all future ladies of the suds to their labours of purification.

Many churches of ancient date were built without any receptacles for bells. The oldest, in the city of Cambridge—Saint Sepulchre's—as far back as the reign of Edward the Second, was raised another story for the reception of bells; and another, of later structure, of Henry the Sixth, at Boconnoc in Cornwall, has a singular belfry, being only eight feet from the ground to the springing of the roof, and the bells—three in number—hanging within two feet of the ground, are rung by the foot.

The tower of the Cathedral Church at Sherborne, in Dorsetshire, contains six large bells, besides the "fire" and the saint's "little bell"; the sixth or tenor bell is said to weigh 60,000 pounds. Why this is not generally introduced in the category of bouncers I cannot account for, without its birth may be in any way doubtful—for it is also recorded to have been brought from Tournay, and presented to the church by Cardinal Wolsey. It

motion of the said levers to be concentric with each other, and with the balance. The pallets are urged towards the wheels by two back springs acting on the respective levers. A compensation for heat and cold may be applied to these, by any of the usual methods, instead of to the balance. The verge or axis of the balance is made in the form of a crank, the arm of which, when the balance wheel is made to vibrate, displaces the levers alternately, so that the pallets act in the teeth of the wheels; the motion continues, because the reaction of the springs is greater in the return of the balance to its former position than in the other parts of the vibration.

Instead of two wheels, may be used one wheel, the teeth of which stand contrate.

2. Stopping the holes with platina, instead of using brass or jewellery in the movements.

[Printed, 6*d*. See Repertory of Arts, vol. 13 (*second series*), p. 73.]

1808, October 31.—No. 3174.

BERROLLAS, Joseph Anthony.— "Infallible "repeating watches." The outside is the same as in a common watch, save that the pendant is mounted with a button consisting of two parts; the lower part immovable, the upper having an endless screw annexed to it, moveable, so as to come out to the extent of four turns. Being turned to the right, it operates on the hour rack; being turned to the left to bring it back again, it operates on the quarter rack. Except that there is a hammer, the movement is the same as that of a common watch that is not a repeater, and thus the extra five wheels, five pinions, barrel and main spring, which repeaters usually have, are avoided. The motion consists of three principal parts; the hour rack, the quarter rack, and the endless screw.

[Printed, 5*d*. See Repertory of Arts, vol. 14 (*second series*), p. 364.]

Presentations

TO THE

BRITISH HOROLOGICAL INSTITUTE.

We intend in future, under the above heading, to record the various presents to the Institute.

It was omitted to be stated in a recent number that Mr. R. R. Hux had presented the Institute with an Eight-day Spring Clock for the use of the Reading Room.

We have pleasure in informing the members that Mr. J. F. Cole has presented the Diagrams that he prepared to illustrate his recent Lecture on the Escapements; they are now hung upon the walls of the Institute for the use of the Members.

Miss Ada Cole has, with the approval of Charles Frodsham, Esq., kindly presented a portrait of his late father, William James Frodsham, F.R.S.

Mr. E. D. Johnson has presented English and French models of Repeating Motions, neatly mounted upon stands.

Mr. G. E. Mylne has deposited a Bronze Bust of the celebrated Abraham Louis Breguet.

EQUATION OF TIME TABLE

For October, 1859.

Day of the Week	Day of Mnth	At Apparent Noon. Equation of Time to be *subtracted* from Apparent Time. m.	s.	Difference for One Hour. s.	At Mean Noon. Equation of Time to be *added* to Mean Time. m.	s.
Sat. ..	1	10	12·77	0·792	10	12·90
Sun. ..	2	10	31·77	0·780	10	31·91
Mon...	3	10	50·49	0·767	10	50·63
Tues..	4	11	8·90	0·753	11	9·03
Wed ..	5	11	26·98	0·739	11	27·12
Thurs.	6	11	44·71	0·724	11	44·86
Fri. ..	7	12	2·07	0·708	12	2·21
Sat. ..	[illegible]	12	19·05	0·690	12	19·19
Sun. ..	9	12	35·61	0·672	12	35·75
Mon...	10	13	51·74	0·653	12	51·88
Tues..	11	13	7·41	0·633	13	7·55
Wed ..	12	13	22·60	0·612	13	22·74
Thurs.	13	13	37·30	0·590	13	37·43
Fri. ..	14	13	51·47	0·567	13	51·60
Sat. ..	15	14	5·08	0·544	14	5·21
Sun. ..	16	14	18·14	0·519	14	18·27
Mon...	17	14	30·60	0·494	14	30·72
Tues..	18	14	42·46	0·468	14	42·57
Wed ..	19	14	53·70	0·442	14	53·81
Thurs.	20	15	4·30	0·414	15	4·40
Fri. ..	21	15	14·23	0·386	15	14·33
Sat. ..	22	15	23·50	0·357	15	23·59
Sun. ..	23	15	32·07	0·328	15	32·16
Mon...	24	15	39·94	0·298	15	40·02
Tues..	25	15	47·12	0·268	15	47·19
Wed ..	26	15	53·56	0·238	15	53·62
Thurs.	27	15	59·28	0·207	15	59·34
Fri. ..	28	16	4·25	0·176	16	4·30
Sat. ..	29	16	8·48	0·145	16	8·52
Sun. ..	30	16	11·95	0·113	16	11·98
Mon...	31	16	14·66	0·080	16	14·68

TO CORRESPONDENTS.

In accordance with the wishes of numerous subscribers, we have Registered this Journal at the Post Office for transmission abroad; henceforward it can be sent per post with the same privilege as a registered newspaper.

A Mechanic is thanked; we regret that the communication was received too late to appear in the present number.

Band.—Berthoud's *Essai* was published in 1763. Reid's Treatise appeared in 1826.

A Constant Reader must forward us his name and address before we can publish his communication.

☞ *We wish it to be distinctly understood that we are not in any way responsible for the views taken by our Correspondents.*

N.B. All Advertisements to be inserted in the Journal must be received before the 25th of the month.

THE BRITISH HOROLOGICAL INSTITUTE.

The Council of the British Horological Institute have the pleasure of announcing to the Members, that arrangements have been made for holding Discussions on Horological subjects at the Rooms of the Institute, 35, Northampton Square, on the Thursday Evening in each week, commencing Thursday the 10th November, at Half-past Seven o'clock. Members are earnestly invited to attend, and take part in these discussions.

The following are the subjects proposed for the under-mentioned Evenings of this month and the first Thursday in December.

Nov. 10.—What are the relative advantages of the Lever and Duplex Escapements? and which may be considered the best for Pocket Timekeepers?—The subject will be opened by Mr. J. F. Cole.

Nov. 17.—Is it advantageous to Jewel a Watch throughout?—To be opened by Mr. Samuel Jackson.

Nov. 24.—What advantages has the Fusee over the Going Barrel? and is the Fusee universally the best for Pocket Watches?

Dec. 1.—What is the reason of the Swiss possessing a larger market for their manufacture than ourselves? and has the Education of the Workmen anything to do with it?—To be opened by Mr. John Jones.

The Members of the Institute and the Trade at large, are earnestly requested to lend their co-operation in the promotion of Horological science, by the reading of Papers or Lectures on any subject connected with Chronometer, Watch, or Clock-making with which they may be specially acquainted; it being considered by the Council that every branch of Horological manufacture from any part of a Movement to its completion would be of interest to the Members. Members or others so disposed, are requested to forward their intentions addressed to the Secretary.

We have the satisfaction of informing the Members of the British Horological Institute that their much-esteemed President, Valentine Knight, Esq., has consented to the request of the Trustees, Vice-Presidents, and Council of the Institute in having his Portrait taken by those eminent Photographists, Messrs. Maull & Polyblank; and that the same, when finished, will be presented to the Members, and placed in the Reading Room of the Institute.

WHAT IS HOROLOGY?

(Continued from page 18.)

Arnold's and Earnshaw's Chronometers.

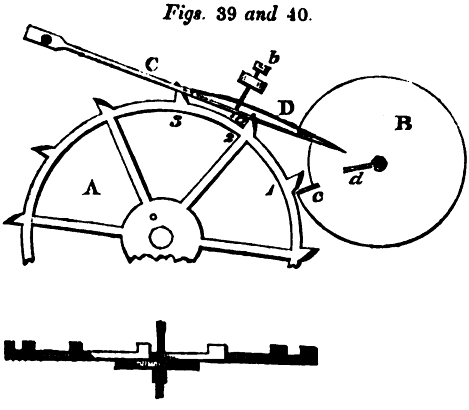
We have already alluded to the fact, that some of Mr. Arnold's chronometers were being tested at the same time that those constructed by Mr. Mudge were under trial; and also that the committee appointed to examine into the merits of the chronometers by the latter artist had mentioned in their report, that two of Mr. Arnold's timekeepers "had gone with a degree of accuracy greater than could be shown on any corresponding trial of Mr. Mudge's." Neither of the two Arnolds at any time placed a chronometer for trial at the Royal Observatory for the express purpose of applying for Parliamentary remuneration; but, attention having been drawn to their timekeepers, and also to those by Mr. Earnshaw, they were pronounced to be superior to Mudge's, both with respect to their accurate going and also in regard to the simplicity and practicability of their construction,—a conclusion which has subsequently been pretty closely adhered to; for the escapements, balances, and springs of Arnold and Earnshaw, especially of the latter, have up to the present time furnished the foundation principles upon which almost all our marine timekeepers are constructed.

The result of the examination of the inventions of the senior Arnold was, that he received £1322 from the Board of Longitude at different times by way of encouragement, and in December, 1805, Mr. Arnold, junior, received a further sum of £1678, making a total of £3000. At the same time, or nearly so, a similar sum was awarded to Mr. Earnshaw, as it appeared difficult to decide which construction was the best.

The main features of the two chronometers we are now about to describe were as follows. In the first place, the escapement was detached, that is to say, the balance vibrated entirely free of the train except at the moment of escaping and receiving impulse. In the next place, the compensation was removed from the pendulum spring and applied to the balance, thus being less direct in its action, but at the same time interfering less with the isochronal properties of the spring. The spring itself was a cylindrical spiral – a form which admits of a more ready adjustment to equal-timed vibrations than the flat spiral.

The movements and trains of these time-keepers were pretty nearly alike, and of the same general form as is now followed. Harrison's maintaining power was applied to the great wheel, and the pinions were of 8 or 10 teeth, according as they were for pocket or box chronometers. Arnold employed very strong main springs in a barrel deeper than the frame, rendering it necessary to attach an elevated bar to the upper plate.

Figs. 39 *and* 40.



In *figures* 39 and 40 A is the escape wheel of Mr. Arnold's chronometer. It has 12 teeth, and is made of brass, the centre being sunk, and a portion of the ends of the teeth projecting upwards from the plane of the wheel. B is the impelling pallet, made of steel, the acting face of which, *c*, is jewelled. C is the locking spring, which is screwed to the under side of the upper plate at its further end; the weakest part is between C and the fixing screw, so that it may nearly be said to turn on it as a centre. About the centre of this spring is a second weaker spring, D, attached to it. This spring is called the unlocking spring, and projects beyond the end of the spring C. At about one-third of the length from this end of the spring C, at *a*, is the locking pallet made of a jewel.* This jewelled pallet, or pin, receives the heel of the tooth, and in the act of unlocking is driven inwards, so as to allow the projecting part of the tooth to pass behind it when the wheel is unlocked. A screw, *b*, tapped into a stud in the upper plate bears against the locking spring to prevent its falling back beyond a certain point. The centre of motion of the unlocking spring is near this screw, and it is free of it in consequence of being narrower than the locking spring. Being therefore weaker, it is at liberty to move back towards the screw head without affecting the position of the locking spring; but when moved in the contrary direction, it must necessarily take the locking spring along with it, and consequently the pallet or pin *a*, which detains the wheel. The unlocking pallet, *a*, is a piece of steel carrying a jewel, and is set in such a position as to follow or precede the face of the large pallet a very little. The angle between their positions is very small in Mr. Arnold's figures, as his locking takes place on the second tooth.

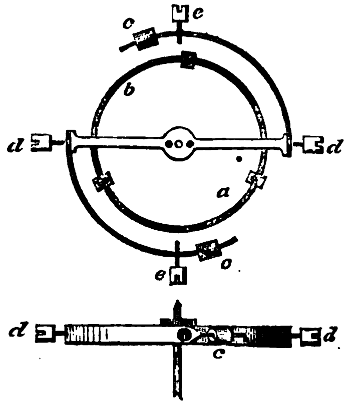
In our figure the unlocking pallet, *d*, has let go the end of the unlocking spring, and the detent has returned to the screw point, to be ready to receive the next following tooth 3, the teeth 1, 2, 3 following one another in succession.

It will be seen that the shape of the teeth of the wheel is peculiar. The acting part of each tooth which is raised from the plane of the wheel is bounded by two straight lines and a curve. The curved portion acts on the jewelled face of the large pallet B, and is called by Mr. Arnold, jun., a cycloidal curve. This curve when applied to the teeth of wheels and pinions enables them to *roll* over one another with the least possible amount of friction. To attain this desirable result, however, both sets of teeth must be truly shaped to the curve in question. In the case before us the tooth of the wheel is curved while the pallet is straight, consequently the curved part of the tooth always acts on the extreme point of the pallet's face, and with a sliding instead of a rolling action.

Figures 41 and 42 exhibit Mr. Arnold's balance – the first in plan, and the second in

* The figures are copied from Mr. Arnold's, and are not very distinct. The locking pin does not show.

Figs. 41 *and* 42.



elevation. The interior ring of metal, *a b*, with three weights of adjustment for position, was added by Mr. Arnold, junior. The expanding rims are about the third part of a circle each, and were originally soldered together and bent into shape with a pair of pliers of a peculiar form. Subsequently, and at the present day, the interior portion at any rate is first turned in the lathe, and the two metals having been united by fusion are subsequently turned and filed to the proper shape and then cut open. Mr. Arnold asserted that the true figure given in the lathe no longer remained when the ring was cut into portions. This opinion was and is still held by many other horologists.

The screws *d d* are for rate. The pieces *c c* have little holes at their exterior ends for a fork screw-driver, and are for the adjustment for temperature, and the two additional screws *e e* are for position adjustment.

Mr. Arnold used a cylindrical spring, and took great pains to ascertain the precise length which should give equal times in long and short vibrations. The trial was made by letting down the mainspring to reduce the vibrations, and setting it up higher to increase their length. He states, that when the chronometer is new and clean, the semi-arc of vibration will amount to 180° or 230°, making the whole vibration from a circle to 460°; but when the oil grows thick, the whole arc will sometimes be reduced to 240°, so that an alteration must take place in the rate if the isochronal properties of the spring were not attended to. Mr. Arnold preferred hardened and tempered springs, although he states that steel wire hard-rolled, or wire made of gold with a proportion of copper, would answer, but were less permanently elastic.

In the box chronometer, in which the balance is of considerable weight, the lower pivot is relieved by making the spring with the coils contiguous. When screwed in its place it is a little stretched, so as to slightly lift the balance. It is evident, however, that if the spring is placed above the balance, as is ordinarily the case, this would make matters worse, as the movement is turned over when in its box and the weight of the balance rests on the upper pivot. Mr. Arnold also lays great stress on his stud being placed so that the end of the balance spring is just half the distance between the centre and circumference of the coils, asserting that this prevents any protrusion of the large coils and preserves the cylindrical shape apparently unaltered by the action.

(*To be continued.*)

LE ROY'S PRIZE CHRONOMETER,

WITH A MEMOIR ON THE BEST METHOD OF MEASURING TIME AT SEA.

(*Continued from page* 22.)

Article III.

Third Cause of Variations in Watches,—the manner in which the Balance is sustained, and the different situations in which they are placed.

It is clear that the weight of the balance occasions on the pivots that sustain it a friction that is both variable and prejudicial; but much less considerable, when, the watch being laid flat, it is carried on the extremity of one of its pivots, than when, hanging, the weight of the balance is borne on the circumference of the two pivots. By what precedes, there follow causes of variations, greater or less, according to the size of the pivots, their polish, the polish of the holes, their depth, the oil which is applied, the weight and size of the balance, the number of its vibrations, their magnitude, the length of the spiral spring, its form, &c. Experience shows, in effect, that most watches, especially those which have dead escapements, lose when hung up. To correct this irregularity, we render the balance more weighty in that part of its circumference which is underneath when the watch is hung up; but by this expedient we palliate the evil rather than destroy it, and we render the watch more subject to vary by shocks and different motions, the effect of which to be done away requires (as we shall presently see) that the balance be throughout of equal weight.

Article IV.

Fourth Inconvenience of Watches,—they lose in heat, and gain in cold.

This effect arises in watches with a dead escapement—1st, From the different causes

which render the vibrations of the regulator greater by heat; 2ndly, Because the dimensions of the balance, and its spring, are augmented by it; 3rdly, From its diminishing the elasticity of the latter. From these united effects there results a variation, greater or less, according to the nature of the escapement, the length and force of the spiral, the greater or less freedom of the balance, &c.

In general, watches with dead escapements advance about five minutes in twenty-four hours, when from the heat of the fob, which is nearly equal to that felt under the tropic, it passes to that degree of cold which produces ice.

If we wish to know how much influence the balance and the spiral spring have separately on these errors, the calculation is easily made.

Experience shows that a steel bar of three feet increases 1-60th of an inch nearly, or $\frac{1}{2160}$th part, when from freezing cold it passes to a heat which raises Reaumur's thermometer* to 30°, about equal to the heat of the fob of a middle-aged man.

Now the weight of a balance being known, the resistance which it gives to the spiral is in the direct ratio of the square of the distance of its circumference of percussion, if we may so express it, from the centre of its motion; and, by theory, the number of vibrations is in the inverse proportion of this distance: therefore a watch taken from the fob to a place where it freezes, when it is arrived at the cold of the place, each of its vibrations, by the contraction of the balance alone, is accelerated the $\frac{1}{2160}$th; that is to say, the watch by this cause advances about $1\frac{1}{3}'$ per hour; the remainder of the gain being produced by the increase of elasticity in the spiral spring, and other causes.

* The degrees of Reaumur's thermometer may be converted to Fahrenheit's by the following equation: $\frac{\text{Reaumur} \times 9}{4} + 32 = \text{Fahrenheit}$, therefore 30° of Reaumur's is = $99\frac{1}{2}$ of Fahrenheit's.

Smeaton, in the Phil. Trans. for 1758, has given the expansion of one foot of blistered steel = $\frac{93}{20000}$dths of a foot for 180° of Fahrenheit, which for three feet at 100° amounts to $\frac{23}{12000}$dths of a foot. Now the English foot is to the French foot as 4000 to 4263; therefore the foregoing expansion in French measure is $\frac{32683}{16000000}$ths of a foot for 30° of Reaumur's, which is nearly $4\frac{1}{2}$ times greater than Le Roy states it. If we had taken hard steel, it would have been greater still in the proportion of 138 to 147.—T. S. E.

Article V.

Fifth Cause of Error in Watches—the little power of the regulators with regard to their motive force.

This inconvenience arises, according to what has been said above, from the resistance of the air, the friction of the suspension, &c. causing a considerable loss of motion in the regulator in each vibration; and since the balance of a watch ought to go of itself (*partir au doight*)* as watchmakers say, (that is, it should be put in motion by the motive force, when this motion has ceased from any cause whatever), this balance can only be very slight. Make the balance of a watch vibrate separately from the wheel-work, and you will see that if at first the vibration is 180° it will lose all its motion in 90″ in a horizontal situation, and in 60″ in a vertical one; instead of which a pendulum preserves the oscillatory motion given to it for twelve or fifteen hours without any foreign help; consequently the impression of the motive force, and the variations which arise from wear and from friction, are in watches, with regard to the effect that they produce on the pendulum, in the proportion of 15 hours, or 900′ to $1\frac{1}{2}'$.

PART III.

Description of the New Marine Watch, and of the means by which we have avoided the different causes of irregularities related above.

Article I.

Of Wheel-work.

If the defects remarked in the construction of watches are the sources whence all their irregularities are derived, in order to render a work of this kind capable of the greatest accuracy possible, it is necessary, consequently, to collect together the opposite properties. Thus, after having given to this work the greatest simplicity of which it is susceptible, it is necessary,

1st, To reduce the friction to the least possible value, and to render the regulator as free and as powerful as possible.

2dly, To give to its vibrations the most perfect isochronism.

3dly, To apply an escapement, by means of which this isochronism cannot be affected.

4thly, To compensate the effects of heat and cold with accuracy and simplicity.

* They are obliged to take this precaution, that the watch may not stop by the different motions which it may receive, and by the losses which it experiences in its motive force from the difficulty with which the wheel-work acts, and the effect produced when the hands are put to the hour, &c.

5thly, To dispose the regulator in such a way that, all the parts being in an unconstrained state, they may remain the same after having been subjected to the greatest differences in temperature.

6thly, To render the machine invariable in the different positions and shocks which it may receive.

This is what I think I have executed in the following construction.

For greater clearness, after having said a few words on wheel-work, I shall treat each of these articles separately, as in the preceding part. M. Bernoulli, in the Researches which I have already cited several times, wishes marine watches to be as large as good clocks are commonly made, that the pieces may be worked with greater exactness, and that their defects, if there are any, may be more easily perceived. This is nearly what I have practised in the New Marine Watch. It goes 38

Plate I. fig. 6.

Plate I. fig. 7.

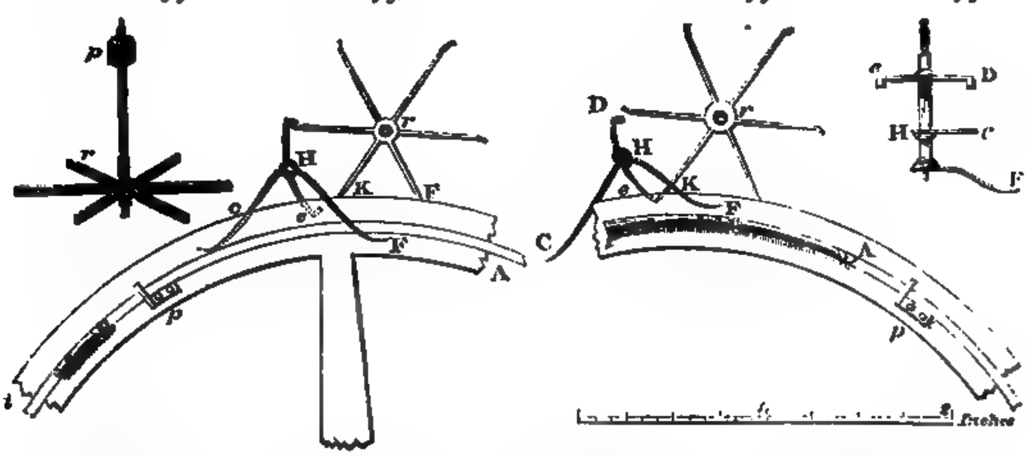
hours. Plate I. *figs.* 6 and 7, shews the plan and profile of the movement on a diameter of three inches. It is composed of a frame, *c c c c*, (*figs.* 6 and 7), containing four flat wheels toothed; the first, placed below the barrel *b b*, containing the mainspring, has 50 teeth, and turns, by means of a pinion of 10 leaves, that of the centre, *m*, which is called the minute wheel, because it makes one turn in an hour, and the minute hand is adjusted on its axis. The minute wheel, by a pinion of 8 leaves, turns the third; and this, by a similar pinion, turns the fourth, called the seconds wheel, because it makes sixty turns in an hour, and carries the seconds hand on its axis. Lastly, the seconds wheel, by a pinion *p*, of 7 leaves (*figs.* 6 and 7 of Plate I. and *fig.* 4 of Plate III.) turns the balance wheel, or rather a ratch or kind of star, *r* (*figs.* 6 and 7, Plate I., and *figs.* 1, 2, 3, 4 of Plate III.), having six radii placed without the frame; it is by means of this wheel that the escapement works.

With regard to the hour wheel, or that which carries the hour hands, H (Plate IV.), it has 48 teeth, and is conducted by a lanthorn pinion of 4, which being adjusted on the axis of the centre wheel *m*, carries the minute hand, *e* (*fig.* 7, Plate I.), on its extremity formed into a square.

By this disposition the hour circle, and those of minutes and seconds, have each one

Plate III. fig. 1.

Plate III. fig. 4. *Plate III. fig. 2.* *Plate III. fig. 3.* *Plate III. fig. 5.*



its centre, as we may see in Plate IV. I have preferred this, although the hour hand necessarily turns to the left, because it suppresses one wheel and some slight friction;* for we can never render a watch destined for the sea sufficiently simple, the accidents which may happen to an instrument being always in the ratio of the number of pieces that compose it.

Moreover, in this wheel-work, the simplicity of which is evident, all the wheels are horizontal, and the escapement wheel moves on the extremity of its pivot; whence arises great freedom in the moving parts.

* Mr. Earnshaw has made this alteration in some of the clocks at the Royal Observatory at Greenwich.—*T. S. E.*

Plate III. fig. 6.

Article II.

Continuation of the Description of the New Watch: means by which the friction has been reduced to the least value, by rendering the regulator as free and as powerful as it can be.

This regulator or balance, *v v v v* (*Fig.* 7, Plate I., and *figs.* 1 and 6, Plate III.) is of steel. It weighs about five ounces; it is four inches in diameter, and is mounted on an arbor, A A *fig.* 7, Plate I., and (*figs.* 6, Plate III.), of about five inches. A frame of copper *x x x x* &c. (*fig.* 6, Plate III.) to which is adapted the movement, holds the balance horizontally, suspended by the upper extremity of its arbor, by means of a very fine harpsichord wire F, which is attached to it, whose length is about three inches, and forms the same vertical right line as the axis of the arbor. That this balance may turn freely on its axis, each of its pivots is retained, with the proper play, between four rollers, turning freely in two small frames *e e*, *e e* (*fig.* 6, Plate III.) the one for the lower pivot adapted to the lower part of the large frame; the other to the upper for the pivot or trunnion *t* (*fig.* 7, Plate I.) at some distance from which is attached the wire of suspension.

All this is arranged with the necessary precautions, so that the wire and the axis of the balance may form always the same vertical line.

This balance thus suspended makes vibrations of about 20" duration each by means of the elasticity of the suspending wire. Two spiral springs, *s s, s s* (*fig.* 6, Plate III.) similar to those which serve as a mover in common watches, adjusted at the bottom of the balance arbor, by means of their ferules, as the spirals in common watches, and in a centre of equilibrium absolutely idle (as M. Daniel Bernoulli recommends in the Researches above cited) act so that these vibrations are each made in about half a second. By this construction I avoid those defects of watches remarked in Articles III. and V. of the preceding part; for, the balance being freely sustained by the suspension wire, the friction which it would occasion by its weight, the very rapid wear which would result from it, &c. are absolutely suppressed, and by means of the rollers, whose properties are well known, those which are produced by the efforts of the regulating spring, by shocks and the lateral motions of the balance, by the effect of the escapement, &c., are reduced to the least quantity; whence it happens that, instead of only preserving its oscillatory motion for about a minute, as the balance of the watch in the experiment related (Article V., Part II), the regulator keeps going here more than half an hour; the two springs contribute also to this; their efforts on the pivots being opposite, are reciprocally destroyed.

Article III.

New Method by which the most perfect Isochronism is given to the vibrations of the balance.

It appears so simple, when we are occupied with the theory of watches, to try, first, whether the different lengths of springs produce no changes in the proportion which exists between the time of their vibrations of different extents, and consequently whether in these lengths there may not be one where the long and short are isochronous. So many reasons, drawn from the principles of philosophy and mechanics, appear to lead us to this conclusion, that we shall find it difficult to conceive how we have hitherto been ignorant of this important fact; much less can we conceive, that it was not till after twenty years researches that we arrived at this discovery. Happily, men of science are not ignorant that the simplest things, almost always the most useful, are frequently so much the more difficult to discover, as, according to the remark of an illustrious Secretary to the Academy, we are less inclined to seek for them.

However it may be, it is constantly the case, as I have already said (Article II., Part *II.*), that in every spring of sufficient extent *there is a certain length* where all the vibrations, whether long or short, are isochronous: I have experienced this in a great number of springs.

To procure, therefore, in the vibrations the most perfect isochronism, I adjust the spiral springs to the balance, and I set the marine watch to go (which, as we have seen, has no fusee) twelve hours in the long arcs and twelve hours in the short arcs; that is to say, twelve hours with the moving spring highly wound up, and twelve hours with it almost unwound. If, in this last case, the going of the watch is more accelerated than in the first, it proves that these springs are too long, and I shorten them. On the contrary, if it is slower, I lengthen them; and thus I proceed until I have found the point where the watch goes very equably both in the high and low strain of the spring: I then diminish or increase the weight of the balance until the watch is regulated. This operation at first appears long; but practice renders it so easy that at first sight I know actually, very nearly, the length of spring where all the vibrations are of equal duration. The two spiral springs are here of some help, because we can only act on the one, and the quantities which we lengthen or shorten it, produce less effect. For example, in my marine watch about one line of diminution in the lower spring makes it gain in the high strain of its mainspring a second and a quarter in six hours more than in the low strain of this spring, where the arcs of vibrations are reduced to about a quarter of what they are when the watch has just been wound up.

I shall add to what precedes, that I am certain, from a number of trials, and easy to verify, that, the long and short arcs of vibration once rendered isochronous by this method, all the intermediate arcs are rendered so also, with the greatest exactness. This is what I do not believe can easily be produced by compensation curbs, by cycloidal cheeks, and other methods, by which they have hitherto attempted to render the vibrations of the spiral springs isochronous; and when, by dint of penetration and care, an artist has perfected such curbs, &c., can others expect to succeed equally as well? The Academy, without doubt, want a machine whose success does not depend on such rare execution. It was probably some case of this kind which made a learned man say, that the novelties produced by artists rarely have their success confirmed by time, it being frequently owing to the particular attention which they pay to the execution of the pieces which they announce as their invention; instead of which, scientific men set a higher value on things more theoretic and less dependent on practice.

(*To be continued.*)

NAME OF MAKER.	Number.	Whether 2 or 8 Days.	Construction of Escapement and Balance, from the description furnished by the Maker	Jan. 8—15. *	Jan. 15—22. *	Jan. 22—29. *
				s.	s.	s.
Campbell	837	2	Ordinary construction of balance with a slight alteration	+ 1·0	+ 2·0	+ 3·0
Frodsham & Baker	6188	2	Auxiliary compensation to the balance (unpublished)	− 6·3	− 5·4	− 3·4
Keys	225	2	Extra compensation acting on the pendulum spring	......	... ..	......
Crisp	130	2	Eiffe's auxiliary to balance	......	−24·6	−27·8
Poole	2059	2	Auxiliary compensation to the balance as in former years	−10·5	−12·8	− 8·6
Webb	5380	2	Auxiliary compensation to the balance as in former years	......	−13·1	−13·9
Frodsham & Baker	6149	2	Auxiliary compensation to the balance (unpublished)	−16·4	−15·5	−16·6
May	$\frac{4}{363}$	2	May's centripetal balance (unpublished)	−14·9	−12·8	−10·2
Russell and Son...	6064	2	Hartnup's balance	......	−31·0	−28·6
Poole	2714	2	Auxiliary compensation to the balance as in former years	− 5·5	− 6·5	− 6·5
Parkinson & Bouts	800	2	Ordinary construction	−21·5	−16·9	−16·1
Hiatt	1946	2	Hartnup's balance	− 2·0	− 6·4	− 7·1
Reid and Sons	1200	2	Auxiliary compensation to the balance acting at low temperatures	− 7·0	−12·1	− 9·9
Porthouse	7201	2	Ordinary construction	−10·7	− 7·0	− 4·4
McGregor and Co.	2760	2	Auxiliary compensation	−19·5	−16·5	−14·8
G. H. & C. Gowland	3185	2	Poole's auxiliary compensation	−18·9	−18·6	−20·0
Lawson	1318	8	Lawson's auxiliary compensation to the balance	.....	−11·8	− 8·1
Wood	523	2	Hartnup's balance	− 4·2	− 2·2	− 1·1
Sewill	1101	8	Hartnup's balance	......	+ 5·2	+ 6·3
Barwise	$\frac{12}{173}$	2	Auxiliary compensation to the balance	−25·9	−18·5	−14·9
Dent	2711	2	Dent's patent balance; see pamphlet "On the Errors of Chronometers," p. 23	......	− 0·1	− 0·8
Blackie	500	2	New auxiliary compensation (unpublished)	......	− 5·4	− 2·2
Sewill	1857	8	Auxiliary compensation acting at low temperatures	......	−24·5	−25·0
Reid and Sons	1204	2	Auxiliary compensation to the balance, acting at low temperatures	+ 4·6	+ 7·4	+12·1
Hewitt and Son ...	2523	8	A new auxiliary compensation (unpublished)	−46·2	−46·3	−44·4
Porthouse...	7230	2	Auxiliary compensation	−25·5	−24·1	−20·4
J. Muirhead	2310	2	Poole's auxiliary compensation	−12·0	− 8·3	− 0·2
Lister and Sons...	587	2	Poole's auxiliary compensation	−18·0	−13·5	−12·6
G.H.&C. Gowland	7195	2	Auxiliary compensation	+ 1·1	+ 1·0	+ 0·7
Moore	3062	2	Poole's auxiliary compensation	−10·6	− 9·8	− 8·6
Davis and Sons ...	471	2	May's centripetal balance	−35·6	−34·3	−36·7
Clark and Son....	3056	2	Poole's auxiliary compensation	−27·1	−30·8	− 1·0
J. French	7005	2	Improved patent compensation for extreme ranges of temperature	......	......	......
Crisp	285	2	Eiffe's auxiliary to balance	......	......	+ 7·1
				*	*	*
Chronometrical Thermometer...	...	..	....	... ..	......	......
Extremes of Temperature as shown by the Self-Registering Thermometer......	...	...	....	° ° 31—49	° ° 35—52	° ° 39—50

of MAKER.	Number.	[illegible]	Balance, from the description furnished by the Maker.	In what Week.	Greatest Weekly Sum.	In what Week.	Diff'rence between the Greatest and Least.	Greatest Diff'rence between one week and the next.	Before and after what Day.
					s.		s.	s.	
Campbell, 7 South Castle-st, Liverpool	837	2	Ordinary const. of bal. with slight alter	March 12 to 19†	+ 6·7	July 16 to 23	9 6	4·7	†June 18†
Frodsham & Baker, 31 Gracech-st, Lon	6158	2	Aux. comp. to the balance (unpub)	April 2 to 9	+ 6·0	May 28 to June 4†	13·0	9·1	†June 25
Keys, 14 Craven-st, Strand, London,	225	2	Extra comp acting on the pend sprng	March 12 to 19†	+ 0 8	June 11 to 18†	13·7	9·4	†June 4†
Crisp, 81 St. John-street-road, London	130	2	Eiffe's auxiliary to balance	Feb. 19 to 26†	− 6·7	July 9 to 16	21·2	7·1	July 9
Poole, 57 Fenchurch street, London	2059	2	Aux. comp. to bal. as in former years	Jan. 15 to 22*	+ 7·6	Feb. 26 to Mar. 5†	20·4	8·0	†June 25
Webb, 4 Pullen's-row, Islington, Lon	5380	2	Auxiliary compensation to balance as in former years	Feb. 12 to 19 / Feb. 19 to 26†	+ 11·5	July 16 to 23	26·0	5·8	†March 12†
Frodsham & Baker, 31 Gracech-st, Lon	6149	2	Auxiliary comp. to balance (unpub)	March 5 to 12†	− 8·2	July 23 to 30	19·9	9·5	†March 19
May, 15 Upper Charles-st, Northampton-square, London	[illegible]	2	May's centripetal balance (unpub)	Jan. 8 to 15*	+ 10·6	June 11 to 18†	25·5	8·4	†March 19
Russell & Son, 30 & 32 Slater-st, Liverp	6064	2	Hartnup's balance	Mar. 5 to 12† / Mar 12 to 19†	− 16 0	July 23 to 30	30·5	11·6	†June 18†
Poole, 57 Fenchurch-street, London,	2714	2	Aux. comp to bal. as in former years	May 28 to Jun. 4†	+ 0·5	April 16 to 23	19·8	12·3	†March 19
Parkinson & Bouts, 59 Gracech-st, Lon	800	2	Ordinary construction	Feb. 26 to Mar. 5†	+ 0 9	July 23 to 30	23·9	11·3	†June 18†
Hiatt, 5 Bath-street, Liverpool	1946	2	Hartnup's balance	Feb. 19 to 26†	+ 8·6	April 16 to 23	28·6	10·9	†March 19
Reid & Sons, 41 Grey-st, Newcastle-upon-Tyne..........................	1200	2	Auxiliary compensation to the balance acting at low temperatures	March 12 to 19†	− 6·1	February 12 to 19	18·6	17·5	†March 19
Porthouse, 16 Northampton-sq, Lond	7201	2	Ordinary construction of balance	Jan. 8 to 15*	+ 12·2	March 26 to April 2	22·9	16·1	April 2
M'Gregor & Co., 38, Clyde-place, Glasgow; and Greenock..	2760	2	Auxiliary compensation	Feb. 5 to 12*	+ 16·4	July 16 to 23	36·7	12 0	April 2
G. H. & C. Gowland, Sunderland...	3185	2	Poole's auxiliary compensation	March 12 to 19†	− 7·9	July 23 to 30	25·9	18·8	†March 19
Lawson, 19 York-pl, City-rd, London	1316	8	Lawson's aux. comp. to the balance	March 12 to 19†	+ 22·4	July 23 to 30	35·8	14·1	†June 18†
Wood, 69 Lord-street, Liverpool ...	523	2	Hartnup's balance	Jan. 8 to 15*	+ 47·4	July 16 to 23	51·6	7·5	†March 19
Sewill, 61 South Castle-st, Liverpool	1101	2	Hartnup's balance	March 12 to 19†	+ 25·6	July 23 to 30	30·8	18·8	†March 19
Barwise, 69, Piccadilly, London......	[illegible]	2	Auxiliary compensation to balance	Jan 8 to 15*	+ 8·3	June 11 to 18†	34·2	16·9	†March 19
Dent, 61, Strand, London	2711	2	Dent's patent balance	Feb 19 to 26†	+ 26·6	June 25 to July 2	37·2	15·6	†March 19
Blackie, 44, Amwell-street, London,	500	2	A new aux. compensation (unpub.)	March 12 to 19†	+ 23·5	July 16 to 23	35·9	10·1	†March 19
Sewill, 61, South Castle-st, Liverpool	1857	8	Aux comp acting at low temperatures	March 12 to 19†	+ 7·2	July 23 to 30	38·3	21·3	†March 19
Reid & Sons, 41, Grey-st, Newcastle-upon-Tyne..........................	1204	2	Auxiliary compensation to the balance acting at low temperatures	March 12 to 19†	+ 31·0	July 23 to 30	35·8	24·1	†March 19
Hewitt & Son, 12, John-st., Mildmay Park, Kingsland, London...	2523	8	A new auxiliary compensation to (unpublished)	Feb. 12 to 19	− 7·8	June 11 to 18†	41·0	21·9	†March 19
Porthouse, 16 Northampton-sq, Lond	7230	2	Auxiliary compensation	Jan 8 to 15*	+ 34 7	July 23 to 30	60·2	13·7	†Feb. 26†
J. Muirhead, Glasgow.....................	2310	2	Poole's auxiliary compensation	March 12 to 19†	+ 4·1	April 9 to 16	32·5	31 3	Feb. 19†
Lister & Sons, Newcastle-upon-Tyne	587	2	Poole's auxiliary compensation	March 12 to 19†	− 12·6	January 22 to 29*	48·9	26·0	Feb. 19†
G. H. & C. Gowland, Sunderland...	7195	2	Auxiliary compensation	Feb. 19 to 26†	+ 44 4	July 23 to 30	51·6	25 2	†March 19
Moore, 114, High-street, Belfast ...	3062	2	Poole's auxiliary compensation	March 12 to 19†	+ 1·2	July 23 to 30	40·8	32·1	†March 19
Davis & Sons, 84, King William-st., City, London	471	2	May's centripetal balance	Jan. 29 to Feb 5*	+ 6·6	June 18 to 25 †	45·0	30·7	Feb. 19†
Clark and Son, Greenock	3056	2	Poole's auxiliary compensation	Jan. 15 to 22*	+ 16·7	February 12 to 19	47·5	29·8	*January 22*
J. French, 62, Cornhill	7005	2	Imp. pat. comp. for extreme temp.	March 12 to 19†	+ 14·4	April 9 to 16	48·9	45·8	†March 19
Crisp, 81 St. John street-road, London	285	2	Eiffe's auxiliary to balance	Feb. 12 to 19	+ 69·5	June 11 to 18 †	67·2	49·9	†March 19

RATES OF CHRONOMETERS ON TRIAL,

FOR PURCHASE BY THE BOARD OF ADMIRALTY,

At the Royal Observatory, Greenwich.

1859.

[*The following* NOTES *are appended to each of the three preceding Tables.*]

(*) During these weeks the Chronometers were exposed to the external air outside a North window. By inadvertence the Chronometrical Thermometer was not placed with the Chronometers on trial during the first three weeks.

(†) During these weeks the Chronometers were placed in the chamber of a stove heated by gas.

The rate given by the first five days of trial is in every case omitted, excepting for Lawson 1318, where the rate for one day only is omitted.

The order of arrangement of the Chronometers in these Tables is determined solely by consideration of their irregularities of rate, as expressed in the columns " Difference between the Greatest and Least," and " Greatest Difference between one Week and the next," without reference to the duration of the trial; the position of Keys 225 is therefore not necessarily correct.

Three Chronometers which became deranged, evidently from some accidental cause, are entirely omitted.

In connexion with this subject, we have the pleasure of stating, that the Council of the British Horological Institute have received from the authorities at the Royal Observatory, Greenwich, complete copies of all the " Reports" of this description which have been published from the year 1840 to the present time, and that the same have been added to the Library of the Institute for the use of the members.—ED. H. J.

THE ANTI-DETACHED, OR REPELLENT LEVER ESCAPEMENT.

By J. F. COLE.

To the Editor of the Horological Journal.

Sir,—The following is a description of an original plan of escapement action, invented by me, and designated " The Anti-Detached, or Repellent Lever Escapement," for which I have applied for letters patent.

The distinguishing point of principle in this invention consists in a reversion of the locking angles of the anchor pallets of lever escapements, in such manner that the alternate pressure of the escape wheel teeth on each locking will throw each pallet respectively out of locking, instead of drawing each pallet respectively into the spaces of the wheel teeth, as is the case in the ordinary Detached Lever Escapement. The first consequence of this difference of direction of the locking angle of each pallet is, that the wheel will have a constant tendency to unlock itself, without offering to the balance or balance spring the slighest difference of resistance at the time of unlocking.

In the Repellent Lever Escapement, the power from the escape wheel is wholly transmitted to the anchor pallets and lever, and from the lever wholly to the balance, with only the smallest possible loss of power by drop of the wheel teeth, as these pallets admit of very close scaping.

On the balance axis is fixed a simple duplex ruby roller only, in such a position on the staff as will agree with the plane of the repellent lever arm, the acting end of which is made in the form of a thin wedge, and of such length as to rest upon the ruby roller, the extreme end of the arm being carefully shortened so as to pass just freely through the roller notch by intersection.

Having thus explained the form and adaptation of the lever arm in connexion with the roller and balance, I now proceed to describe the acting effect of the anchor pallets, on which the escape wheel pressure is constant, except at the moment of escaping. The wheel tooth then drops on one of the lockings, and by the small incline of the locking face the impulse end of the lever is brought to rest on the outside of the roller with a very small amount of pressure. In this condition of the lever arm one of the lockings will arrest a tooth of the wheel by only a sufficiently sound engagement; and if the balance and roller be moved in the direction of the lever force, the wedge-formed point of the lever will enter the roller notch without any drop, and give impulse to the roller and balance with the fullest effect, as, on the wheel tooth passing over the locking edge of the pallet, impulse will be given by the wheel to the pallets, either by using a star wheel with pointed teeth, with or without under-cutting, such wheel in this case giving impulse on the long impulse plane of each pallet respectively in the manner of ordinary trade-manufactured pallets, as regards the impulse planes only of such pallets; or, otherwise, the impulse from the wheel to the pallets may be made by cutting the escape wheel as an ordinary club-toothed lever wheel, with the impulse planes partly on the wheel teeth and also partly on the anchor pallets. But the mode or method I prefer to adopt is by forming the escape wheel with the

impulse planes entirely on the wheel teeth, instead of on the pallets; in this case the anchor is formed by setting pallets of ruby or other suitable stone into the anchor piece, in such manner, and at such an angle for locking, as will effect the repellent action of each pallet respectively, the said ruby pallets having the locking edges smoothly finished for receiving impulse from the long incline formed upon each tooth of this kind of escape wheel, the ruby pallet edges being set so as to represent arms of equal radius, or nearly so.

The three modes of giving impulse to the pallets by a single incline, either on the respective pallets or on the wheel teeth, are the already adopted modes of impulse in detached lever escapements; and therefore the principle hereinbefore described consists in the combination of two angles upon each pallet, the first angle for the locking being the lesser angle, while the angle for impulse is the greater angle in regard to the power given out by the pressure of the escape wheel, as described in the three before-mentioned modes of the wheel and pallet action; and therefore what I claim as my invention is the formation of two differential angles on each pallet respectively, for the express purpose of impelling the said pallets to the right hand or to the left hand, *with differential force on each pallet while moving in the same direction* on either side respectively over the locking and impulse planes; and also in giving impulse from the lever arm to the balance entirely by the wedge-formed extremity of the lever arm acting on the sides and edges of the notch of the ruby roller.

The lever arm may be made of hard gold or other suitable material, or a simple pin inserted radially into any suitable part of the anchor will answer the same purpose.

The length of the lever arm being about equal to the radius of the anchor pallet arms, any little deviation from such length will be of no material consequence, provided the diameter of the ruby roller be so adapted to the scaping arc of motion of the anchor pallets as will produce about 30 degrees of motion as the scaping arc of the roller and balance. The balance arc may be more or less, at discretion, according to the proportions preferred for all or any of the acting parts. I do not confine myself to the employment of angular pallets only, as the pallets can be made to act, less perfectly, by straight line single-plane or curved surfaces for the impulse and lockings.

J. F. Cole.

[The properties and advantages of Mr. J. F. Cole's Repellent Lever Escapement, will be given, with an Engraving, in the next number of the Journal.—Ed. H. J.]

A FEW WORDS IN DEFENCE OF

ENGLISH WATCH-WORK.

By a Mechanic.

(*Concluded from* Vol. I. p. 160.)

Having now pointed out how, in all the main features of horological art, Englishmen may substantiate their claim to originality, it remains only to add, that in the more fanciful portions, namely, the orrery or planetarium, repeating, calendar, electric, and astronomical varieties of machinery, abundant illustration of the genius of Britons is to be found.

Having been permitted thus far, as an Englishman and a watchmaker, to speak in defence of English watch work, I might be mistaken for a mere partisan, and my task would be most incomplete, did I pretend to ignore the fact, that the manufacture that should be the result of all this research and ingenuity is rather on the decline in England—*here, in England, the workshop of the world!* But that such is the case none can doubt; and it is therefore I conceive that the best word that can be spoken in defence of English watch-making will be the suggestion of the probable cause of this decline, and an indication of the possible remedy, or means by which to achieve its revival.

The following propositions will, I venture to predicate, be undisputed; in fact, they have been asserted often before, but always in the mere spirit of the braggart, while I repeat them in pure love of the art, for the purpose of drawing conclusions therefrom:—

Firstly, England has very ancient claims to recognition.

Secondly, England is essentially a manufacturing country.

Thirdly, England is pre-eminent for machinery and tools.

Fourthly, England is the world's depôt for material.

Fifthly, England originated the cause (steam travelling) of the conversion of "Timekeepers a luxury" into "Timekeepers a necessity."

To these I may add my own testimony, that I never yet saw a piece of work appertaining to horological machinery done by a foreigner that I could not find an Englishman to equal, with one notable exception,—in the arts of design and combination; but herein their deficiency was as complete as their skill in execution was consummate.

From the above, combined with the known fact of the disposition amongst English watch-

makers to lean upon the reputation of their forefathers, and the remarkable pride English workmen take in educated fingers, I draw the following conclusion—namely, that, with the before-mentioned advantages, nothing but a combination of ignorance, conceit, and division could possibly keep inactive so glorious a list of natural advantages—a list including nearly every element of success. I, therefore, judge that to be the cause of the decline; while, as nothing but a recognition of the force of union is required to render them effective to the development of that art which is the most solid benefit of those engaged in it, I judge that herein lies the remedy.

The best defence, then, of watchmaking in England is to combine for education and comparison of ideas; to combine for the decision and adoption of standard gauges and uniform measuring instruments;—to combine for the reduction of the useless variety of sizes;—to study how advanced machinery may be made to relieve the brain from mere drudgery, and so give more time for the study of art;—above all, to combine for the prevention of that fatal development of the "division of labour" idea, which ends in making a man into a bad machine and destroying his thinking powers.

That herein you would find your reward, Brother Watchmakers, in the individual as well as collective benefits that would flow from a well-developed art; and that that development is the one thing needed, is the opinion of

A Mechanic.

THE BIRTH OF WATCHMAKING IN SWITZERLAND.

[Mr. Guinaud has kindly presented to the Institute a finely executed medallion likeness of the ingenious Richard, who made the first watch in Switzerland; in reference to which we subjoin the following details, taken from an interesting account given by the celebrated M. Houriet, watch manufacturer, of Locle.]

The art and trade of watch making was first introduced into the mountains of Neufchatel in a manner worthy of notice.

As early as the seventeenth century some workmen had constructed wooden clocks with weights, after the model of the parish clock, which was placed in the church of Locle in the year 1630. But no idea had been as yet conceived of making clocks with springs. It was only about the latter end of the same century that an inhabitant of these mountains, having returned from a long voyage, brought back with him a watch—an object which was till that time unknown in the country. Being obliged to have his watch repaired, he carried it to a mechanic named Richard, who had the reputation of being a skilful workman. Richard succeeded in repairing the watch; and having attentively examined its mechanism, conceived the idea of constructing a similar article. By dint of labour and perseverance he at length succeeded, though not without having had great difficulties to surmount, as he was compelled to construct all the different movements of the watch, and even to manufacture some ill-finished tools in order to assist him in his labours. When this undertaking was completed it created a great sensation in the country, and excited the emulation of several men of genius to imitate the example of their fellow-citizen; and thus, very fortunately, the art of watchmaking was gradually introduced among our mountains, whose inhabitants had hitherto exercised no other trade or profession than those which were strictly necessary to their daily wants, their time being principally employed in cultivating an ungrateful and unproductive soil. Our mountaineers were frequently compelled, before the introduction of the above-named branch of industry, to seek for work during the summer months among the population of the surrounding country. They rejoined their families in the winter, being enabled from their economical savings, the moderation of their wants, and the produce of a small portion of land, to supply themselves with the necessaries of life. And it must be remarked, also, that the entire liberty which they enjoyed, united to the absence of any description of taxation, greatly tended to relieve the hardships of their lot.

SIZES OF PINIONS.

To the Editor of the Horological Journal.

Sir,—Your Correspondent C——y, in the last number of your Journal, must have been misinformed when he applied to *Watchmaking* the sizes he states.

I forward, enclosed, a translation from Berthoud, which he quotes as referring to the subject, from Vol. I., page 172.

For a pinion of—

16, six full teeth.
15, not quite six full teeth.
14, six teeth from point to point.
12, five full teeth, if for a clock; if for a watch, five points rather full.
10, four full teeth.
9, somewhat less than four full teeth.
8, if for a clock, four points; and if for watches, one fourth of a space less.

For a pinion of—

7, in clocks, three teeth and one fourth of a space; in watches, a trifle less than three teeth.

6, three teeth for clocks; three points for watches.

Should you deem it desirable, I will with pleasure place this volume, for a limited period, under your care in the library of your Institution. I am, Sir, your's respectfully,

H. Delolme.

48, Rathbone-place, London, October 8th, 1859.

COLE'S RESILIENT LEVER ESCAPEMENT.

To the Editor of the Horological Journal.

Sir,—I have much pleasure in informing you that an acting model of my Resilient Lever Escapement has been made for presentation to the British Horological Institute, by Mr. Egbert Storer, who has so far interested himself in the principle as to have carried it correctly into practice; this will be seen by the motion produced; and as there is no set on the lockings or impulse, I consider the result entirely satisfactory.

This model having been submitted for my supervision, I have taken the opportunity of applying a tempered pendulum spring, as an illustration of the double volute, with close attachments at the stud and collet, intended for lessening the excentric force of the spring, and consequently the position errors of the watch. I am, Sir, your's very respectfully,

October 18th, 1859. James F. Cole.

ABRIDGMENTS OF SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

Printed by order of the Commissioners of Patents, and published at the Great Seal Patent Office, 25, Southampton-Buildings.

(*Continued from page* 29.)

1808, August 24.—No. 3164.

CONGREVE, William.— Detaching the time measurer from the first mover, for a greater duration of time.

1. The inventor takes as his time measurer "a "perfectly detached body descending freely down an "inclined way." A tube is connected with the train by an arbor and pinion, and a ball runs down this tube, in consequence of its being inclined, from one end to the other; it then strikes a detent which held the tube in its then position, and the tube, being discharged, makes a half revolution, and is caught by the detent again. The ball is thus brought to the upper end again, and of course descends again. By varying the length and inclination of the tube, the ball can be made to make more or fewer descents in a minute. By having an inclined plane with grooves on it, the patentee carries his invention so far as to get an extension of detachment of the duration of a minute, or more. He also varies the principle by using two or more balls.

2. He accomplishes the same effect by a simple pendulum. A light spring wheel of 30 teeth is unconnected with anything but the seconds hand, and a pair of pallets. Another pallet, on the same stock, is connected with a large wheel of 60 teeth. On the face of this wheel are 60 pins, and a lever acting on these locks the wheel. On the face of the little wheel is one pin. A seconds pendulum being set in motion, the pallets drive the little wheel, and at the 60th second the pin discharges the lever from the pins of the large wheel. This, being thus unlocked, starts forward from the action of the first mover, and one of its teeth striking the pallet of the large wheel, gives renewed motion to the pendulum. When the pin on the little wheel has passed the lever, the lever relocks the large wheel, for another 59 seconds.

[Printed, 11*d*. See Repertory of Arts. vol. 14 (*second series*), p. 1; and Rolls Chapel Reports, 7th Report, p. 107.]

1808, December 20.—No. 3185.

SCHMIDT, John.—1. "A Phantasmagoric Chro- "nometer, or Nocturnal Dial." A vase or any case has on one side a watch with two dials, the outer one being the day, the inner one the night dial. The night dial is a concave reflector of highly polished metal, with the figures of the hours engraved reversely on it. On the side of the vase opposite to the night dial is a tube, in which are a combination of glasses or a single glass. In the foot of the vase is shut in a light. The works are between the dials, and the hour and minute wheels are of course double.

2. "The Mysterious Circulator, or Chronological "Equilibrium," which may be applied instead of the above, or may be used as a separate timepiece, or as an orrery. The work of any watch is fixed in a box representing the earth. A weight is fixed to the hour-hand wheel. The box and weight are fixed to one end of a lever, through which passes a steel centre or axis, and to the other end of the lever is a box with sufficient lead in it to counterbalance in any position. The whole rests on a stand, on which is also supported the dial; the hours and minutes being shown by one hand only, or, instead, a nonius being applied to subdivide the minutes. To use this as a nocturnal dial, the reflector above described is fixed to the steel axis. To represent the increase, decrease, and revolution of the moon, an apparatus is fixed to the back of the box containing the watchwork, in such a manner as to make what is taken to represent the moon invisible when between the sun and earth (the centre piece being the sun, and the box the earth), and then when turning round gradually to increase, showing the first

quarter &c. &c., on the proper day, for which reason the number of days in the month are engraved upon a brass circle fixed round the box.

[Printed, 6*d*. See Repertory of Arts, 17 (*second series*) p. 9; and Rolls Chapel Reports, 7th Report, p. 202.]

1810, May 26.—No. 3342.

BERROLLAS, Joseph Anthony.—"A warning "watch on a new construction." The patentee says, "The inside of the movement is not different from a "common watch, excepting a barrel, which is fixed "with two screws on the under side of the top plate, "as near to the mainspring as possible. The arbor "of the side barrel is made in the same manner as a "clock watch, has a brass wheel with sixty teeth, "with a steel wheel fixed to it, which steel wheel has "33 teeth, cut like a ratchet, which causes the ham- "mer to act. The hammer is placed between the "main and warning barrels, and the side hammer "strikes on a bell spring, which bell spring is fixed "with two screws on the pillar plate. The spring in "the warning barrel is wound up five times, which "occasions the hammer to give one hundred and "sixty-five knocks on the bell spring. Opposite the "hammer is a pinion with six teeth, which acts in the "arbor wheel; this pinion is planted on one side of "the upper plate, and on the other in a bar in the "back of the pillar plate." On the side pinion is a wheel with forty-five teeth, which wheel acts in a pinion with six teeth, planted in the said bar on one side, and in the pillar plate on the other. On the said pinion is a wheel with twenty teeth, like a ratchet, which acts in a pallet. These form the warning parts, the said pallet being the one acted on by the detent of the warning.

[Printed, 5*d*. See Repertory of Arts, vol. 17 (*second series*), p. 257: and Rolls Chapel Reports, 7th Report, p. 110.]

1811, September 9.—No. 3487.

CHANCELLOR, John.—Musical instrument applicable to clocks. A solid piece of brass or bell metal is fixed in a case, the upper part of which is called the sounding board, by screws through the sides, so as to allow the said piece to move on the points of the screws as on an axis. The piece is so placed as to be nearly touching the sounding board. Bars of steel or bell metal are fastened, each by one end, to the piece, the bars (in preference made in an elliptical form) varying in length, breadth, and thickness, according to the intended note to be produced The bars are struck by hammers, which are worked by the pinned cylinder or barrel of a clock.

Keys may be provided instead of the cylinder, so as to perform by hand.

[Printed, 6*d*. See Rolls Chapel Reports, 8th Report, p. 87.]

EQUATION OF TIME TABLE

For November, 1859.

Day of the Week	Day of Mnth	At Apparent Noon — Equation of Time to be *subtracted* from Apparent Time.	Difference for One Hour.	At Mean Noon. — Equation of Time to be *added* to Mean Time.
		m s	s.	m. s.
Tues..	1	16 16·59	0·048	16 16·60
Wed ..	2	16 17·75	0·015	16 17·75
Thurs.	3	16 18·11	0·018	16 18·11
Fri. ..	4	16 17·69	0·051	16 17·68
Sat. ..	5	16 16·46	0·085	16 16·44
Sun. ..	6	16 14·43	0·119	16 14·40
Mon...	7	16 11·58	0·154	16 11·54
Tues..	8	16 7·89	0·188	16 7·84
Wed ..	9	16 3·37	0·223	16 3·31
Thurs.	10	15 58·01	0·259	15 57·94
Fri. ..	11	15 51·80	0·294	15 51·72
Sat. ..	12	15 44·74	0·330	15 44·65
Sun...	13	15 36·81	0·366	15 36·72
Mon...	14	15 28·03	0·402	15 27·93
Tues..	15	15 18·39	0·437	15 18·28
Wed..	16	15 7·88	0·473	15 7·76
Thurs.	17	14 56·52	0·509	14 56·39
Fri. ..	18	14 44·29	0·545	14 44·16
Sat. ..	19	14 31·21	0·580	14 31·07
Sun...	20	14 17·31	0 614	14 17·16
Mon...	21	14 2·57	0·648	14 2·41
Tues..	22	13 47·00	0·682	13 46·84
Wed ..	23	13 30·63	0·715	13 30·47
Thurs.	24	13 13·47	0·748	13 13·30
Fri. ..	25	12 55·53	0·779	12 55·36
Sat. ..	26	12 36·84	0·810	12 36·67
Sun. ..	27	12 17·41	0·839	12 17·24
Mon...	28	11 57·26	0·868	11 57·09
Tues..	29	11 36·43	0·896	11 36·26
Wed ..	30	11 14·92	0·924	11 14·75

TO CORRESPONDENTS, &c.

In accordance with the wishes of numerous subscribers, we have Registered this Journal at the Post Office for transmission abroad; henceforward it can be sent per post with the same privilege as a registered newspaper.

J. Jones's communication has been received, but further notice of it is deferred till our next number.

S. of St. Andrews desires to know if any of our Correspondents can give him any information as to a Clockmaker named "Joseph Knibb, London," who, it seems, was also a maker of philosophical instruments. He is anxious to know about what time he lived.

☞ *We wish it to be distinctly understood that we are not in any way responsible for the views taken by our Correspondents.*

N.B. All Advertisements to be inserted in the Journal must be received before the 25th of the month.

THE BRITISH HOROLOGICAL INSTITUTE.

DISCUSSION MEETINGS.

Meetings for discussion of the questions prepared by the Museum and Lecture Committee, which we announced in our last number as proposed to be undertaken from time to time at the Institute, have been duly held as advertised; and, judging from the interest evinced by the numerous attendance of members, the rooms on each occasion being well filled, they have been successful, and, we may think, beneficial.

The *first*, held on the 10th November, was opened by Mr. J. F. Cole, one of the Vice-Presidents, being "*On the relative merits of the Duplex and Lever Escapements; and which may be considered the best for Pocket Timekeepers?*" Mr. Adam Thompson, of New Bond-street, in the chair.

Mr. Cole opened the question by introducing to the meeting the particular principles of the duplex escapement, enlarging on its simplicity of construction for communicating impulse to the balance, and describing with considerable detail the proper proportions requisite for its correct make. With reference to the size of the ruby roller, about which some question existed, he had found that a diameter equal to one-fifth of the distance from point to point of two of the teeth of repose would be the smallest diameter suitable, one-fourth of the same distance being the largest he would recommend, the wheel in all cases being the index of proportion. He stated that, in his experience, even with a correctly made duplex escapement the adjustment of this watch was attended with more trouble than those made with the lever. Mr. Cole then proceeded to consider the lever escapement, which he very fully explained in its principles as set forth in his Lecture, calling attention to the essential points of the lockings and lever impulses, the safety action, and to the law which governed their relations; also referring to the size of the escape wheel whether of the extreme size of half the diameter of the balance, or the recommendable medium between that and the smallest diameter, two-fifths, he proceeded to develop the relationship of the angle of the pallets with the length of the lever and diameter of the roller by the aid of his diagram No. 3 on the walls of the Institute, explaining that whether a large angle of 12 degrees on the pallet, as is customarily used (and there set forth), or a small one of 8, or the medium of 10 (which he recommended), were employed, about the same arc of escapement at the balance should be evolved by adopting a corresponding proportion of lever and roller, and would be attended with about equally satisfactory results. In the case of the use of a smaller angle on the pallets than 8 degrees—say 6 degrees—there might be a liability of abutment of the wheel teeth in backing the pallets, but with an angle of 8 degrees he had found these escapements attended with the best results. Having thus developed the principles of the two escapements, he left it to the meeting to pronounce its opinion as to the relative advantages of either.

Mr. Guinand (on the invitation of the Chairman) expressed in very energetic terms his regret at the present neglect of an escapement so accurate and simple as the duplex; in fact, he considered it was quite gone down—was being buried alive. Having made some 2000, he was warranted in the assertion that the escapement was a very simple one, and that there was no ground for its present disfavour, as it was readily made so as to secure satisfactory results. He attributed its not being in demand to the fact of the vendor asking a very high price for a duplex watch beyond a lever. In evidence of its superior time-keeping advantages, he referred to an escapement he had made for one of two portable clocks, the other being furnished with a chronometer escapement, and the two going under similar conditions; he was assured that the duplex had given the steadiest result, and of this he felt as proud as if the *Croix d' Honneur* had been conferred on him.

Mr. Jackson followed, observing that every one who pursued any branch of watch-making for a living must, by the sedulous attention required for success, have some experience worthy of notice. Having made both the escapements, he considered the duplex to offer one important advantage in use, in the greater facility with which the watch was brought to time in positions, and for its steady rate; but its extreme nicety, and greater liability to injury when subject to more than ordinary external motion, compared with the lever, might, with its greater expense, account for its present comparative disuse; but he did not think with Mr. Guinand that it was defunct. The duplex, in addition to the greater nicety of its requirements and its liability to injury, although a dead escapement, seemed to him to have some disadvantage in that the tooth of repose, though acting so near the centre, would, with oil not quite fluid, in the return vibrations of the balance, exert an injurious influence over the pendulum spring in the very slight recoil at the passage of the notch. And an advantage which it appeared to him the lever possessed, in addition to its detachment, was, that at each vibration of the balance an impulse was given, while in the duplex there seemed an impulse lost. (It should be remembered that they were considering the escapement as applied to pocket watches. The pendulum spring having to bring back the balance past the point of rest, and having carried it thence forward another semi-vibration,

again has to return it to the point of impulse, and this, he thought, had much to do with the liability of the duplex escapement to set.

Mr. Cole explained, with reference to Mr. Jackson's remark as to the divided impulse, that though there were not two impulses in the duplex, as in the lever escapement, there were also not two unlockings in the former; and that, in his opinion, the sum of the force exerted would be the same in both cases, less the loss by the passage through the roller.

Mr. Isaacs said, though young in experience he had made both escapements, and timed them; but gave his preference to the duplex. He concurred with Mr. Cole's remark as to a common misapprehension of the advantage of a large roller to the lever escapement, thereby diminishing the safety of the guard pin; but proportions were often given to escapement makers to work to.

Mr. Marsh followed on the same side, giving as the result of his experience the superiority of the duplex escapement for time-keeping.

Mr. Egbert Storer gave his preference to the duplex when made correctly, and concurred with Mr. Guinand in thinking that its present desuetude was owing to the want of judgment in the treatment of the escapement after it had passed from the hands of the maker.

Mr. Watson said, the duplex communicating impulse directly from the escape wheel to the balance without the intervention of a lever seemed to him, theoretically, the more correct, and for that reason he preferred it.

The Chairman closed the proceedings with a few remarks relative to the duplex escapement, and announced the next meeting for the 17th.

After a vote of thanks to the Chairman, the meeting separated.

The *second* of the series of Discussions on Watch-making was held on Thursday, November 17th, in the rooms of the Institute. J. Stoddart, Esq., of Red Lion Street, one of the Vice-Presidents, took the chair at eight o'clock, and introduced the Question, "*Is it advantageous to jewel a Watch throughout?*" by a few remarks, in the course of which he observed, that whatever the material of which pivot holes for watches were made, whether jewels or not, an essential consideration was the intervention of oil, which in its best condition was to be regarded as a number—he might say an infinite number—of fine rollers, by which the friction of the pivot against the hole was reduced.

Mr. Jackson then opened the question as follows:—

The question "Is it advantageous to jewel a watch throughout?" seems to me to depend much upon the character of the watch, whether one of limited price, or one of a class where expense is less an object, say an adjusted watch. If advantageous for the higher class, it will follow, as far as possible, it must be so for the cheaper.

It were best then to consider whether it is advantageous to time-keeping to jewel a watch throughout. By jewelling throughout will be *generally understood* all the pivots of the train, from the fusee to the scape wheel, also the escapement and its actions,

Now, I understand the advantages of jewel holes to consist chiefly in two qualities they possess:—1st, Their hardness and consequent polish, by which they preserve the pivots of the axes and are themselves preserved from wear, and so maintain the same constant relative distances of the wheels and of the escapement for their impulses, that is, prevent the pitching depths being shifted in the course of years of wear. 2dly, Finer holes may be used than can be employed in metal, whereby the frictional surfaces are much diminished.

These two advantages, of diminished frictional surface and durability, are contingent absolutely, in the use of jewelled holes, on the three following conditions, viz.:—1st, That these holes are quite true; 2dly, That they are perfectly well polished; 3dly, That in their setting they are perpendicular to their plane, and true to its centre.

The two advantages above referred to are of the greatest importance, and invaluable in the escapement.

The question of the condition of the oil in wear with the jewel hole is one on which experience seems divided, differing perhaps as the chemical nature of the oil differs. Some hold that the oil in the jewel hole sooner loses its fluidity, coagulating into a kind of jelly, which offers a resistance to the motion of the pivots; but it is to be said that in the diminished surface, by the finer holes possible with the jewel holes, a more than compensating advantage is obtained; and this advantage is increased when the natural effects of friction on the metal hole is considered, by which portions of the metal are worn off and mixed with the oil, as is well known and observed, particularly in the back centre, third, and fourth holes of watches, where they are not jewelled.

Admitting that this coagulation of the oil takes place with the jewel hole, it still lubricates and diminishes the friction, while the metal hole sooner perhaps assists in the absorption of the oil, and what is left round the pivot is of the nature of a cutting paste.

Starting with the escapement, there are few who would, I consider, dispute the advantage, in a completely adjusted watch, of jewelling this part throughout. Rapid motion, great friction on the pivots and on the acting planes with the power of the train at its greatest diminution, exhibit all the conditions in which jewelling would be advantageous. With the use of jewel holes, a diminution of the rubbing surfaces by finer pivots and with the use of end stones, a continued fluidity of the oil, with the constantly exact relative position of the acting parts, all so vitally essential in the escapement, are secured.

It may here be added, that we appear to have been indebted to the ingenuity of the Swiss for the introduction of jewel holes. M. Facio, an eminent watchmaker of Geneva, about the year 1700, applied them first to the pivots of his escapements. (Remark, the inventor first applied them to the escapement only). He went to Paris, and meeting with little encouragement, came to London, where he was eminently successful.

Passing from the escapement to the fourth wheel. Its frequent revolutions, 1440 per day,—

being immediately in contact with the escapement, —its seconds hole exposed to the deterioration of the oil under the seconds' hand, would decide us in favour of jewelling these holes, more especially that hole nearest to where the power is communicated from the third wheel, which varies in different calibre movements, being reversed in some, as in the centre seconds train.

The third wheel has fewer revolutions, only 192 per day, but having the pressure on the pivots increased (being a cross depth, as it is termed, or pitched on two wheels), I would jewel it in a first-class watch, but always, where possible, in that hole nearest to where the power is received in most watches,—the bar hole, which, as has been remarked, is known to wear soonest. In a full plate watch of the first class I think the upper third and fourth holes should be jewelled, as offering some protection from the effect of the vibrations of the balance, which, passing near its circumference to and fro over these holes, has a tendency to sweep, as it were, fine particles of dust into these holes, and so deteriorate the fluid property of the oil.

Coming to the centre and fusee holes, like reasons seem to me to be applicable to both of these actions as to employing jewelled holes. Their motion is so slow, 24 and 4½ or 5 revolutions per day respectively, that the question of friction, as *diminishing seriously* the power through the train, is scarcely raised. I think therefore, although many very expensive watches have these holes jewelled, it is a costly superfluity.

In the highest class and most costly timekeepers, the marine chronometer, where the additional expense would not be regarded, there is scarcely any wheel hole jewelled beyond the fourth; and what, I think, may be urged as a valid reason for not jewelling in these the fusee and centre holes, is the liability to breakage from pressure, which may be considerable in a wearer's hand, whether on the winding or on the set hand square, and to this extreme pressure these holes are alone exposed, and the inconvenience of their fracture would be very great, as, besides being very expensive, they would not, as in the case of most jewel holes, be everywhere easily replaced.

True economy in watch-work is a principle, it will be admitted, of important consequence; for outlay essential in one part will limit the advantage of needful expenditure on parts that are of vital importance, as in the time devoted to the escapement, timing, &c.

Without alluding to the practice that prevails of not jewelling many of the first-class timekeepers beyond the fourth holes, as regards them, I think the question of this evening may be fairly answered in the negative. But, before asking your opinion, if not your affirmation of this, I would say a few words as to watches for ordinary use, where the same accuracy is not required. If in the adjusted watch it is not of advantage to timekeeping to jewel all the holes, still less is it so in watches made up in quantities, and where results cannot be so well tested; in fact, except in the next hole to the escapement, the fourth or seconds' hole, it appears to me of advantage to leave the other train holes in metal; for if a depth is wrong, or a wheel is untrue, it is much better and easier corrected than with a jewel hole; and with a sound metal hole properly upright the wear is of many years duration; and, by comparison with a soft stone or one ill polished or not upright, to which a cheap watch is liable, it is much superior. The escapement is the part which should always be jewelled throughout, where possible; but the consideration of the question brings me to conclude against jewelling the watch throughout.

As a practical confirmation by experience of the views taken of the little advantage derived from jewelling the centre and fusee holes, I may mention that a watch made by my late brother, and which next May will have been exactly twenty years in constant wear, has within the last two or three days come into my hands in which the fusee and centre holes and pivots are in the same condition and as unimpaired as when first made; the only protection to the fusee upper hole being a well-fitted cap on the winding square.

Mr. Jackson concluded by referring to a paper of "Remarks" with which he had been favoured by Mr. W. B. Crisp, whose experience as therein expressed confirmed his own, and who writes with regard to the effect of oil upon jewelled holes: "I have invariably found the oil at the fourth hole when jewelled to become exceedingly thick and glutinous after a few months performance of the timekeeper—in fact, so thick at the seconds hole as to quite bind the pivot, so that *force* was required to remove it, but have rarely noticed the pivot to be cut; the only injury apparent being a deep stain, not removable, except by slightly polishing; but where the seconds hole has not been jewelled, a few months wear with even free oil, has sufficed to deeply cut this pivot, rendering repair and sometimes a new hole needful. I have also occasionally found the back centre pivot much cut. Do these effects arise from these holes being more exposed to the air than those under the dial?

Mr. R. R. Hux said, During the early part of last century subjects in connection with horology were frequently discussed at the Royal Society. In a discussion upon a question similar to that of this evening, the President (Sir Isaac Newton) remarked, that the best metal for holes when burnished was bell-metal, and that it was customary with workmen to wipe off some of the oil they put upon the pivots and then apply a little *very fine* black lead, which was found greatly to reduce friction, but that watches with ruby holes needed no oil; though he (Mr. Hux) could not say from experience that such was the case. Regarding what had been said about oil getting glutinous sooner at jewel than brass holes, he thought there must in such cases always be a cause to produce that result, not even excepting the particular instance mentioned by Mr. Crisp. Leaving out the mere question of cost, and taking durability into consideration, if called upon to produce a watch that should be as good in fifty years as the first day it was placed in the wearer's hands, he should jewel that watch throughout; but there were three conditions that must be complied with to successfully accomplish that object, otherwise you would destroy what it was intended to preserve. The firse condition was, that the jeweller must produce his work perfect; the jewel must be finished before being set, and not, as was often the case, after-

wards, as by that plan there was danger of some particle of diamond powder coming in contact with the setting, which all the boiling-out could not remove; hence, when the watch was going, if the smallest particle of powder by any chance was communicated to the oil, and thence to the pivot, it would result in the oil becoming in a very short time discoloured and glutinous. Second condition, that, having perfect jewelling, the pivots must be as near perfection as possible, and to that end they must be properly burnished. The surface of a pivot not properly burnished was apt, during the going of the watch, to throw off minute particles, thus another cause which produced the discoloration and glutinous matter so justly complained of. The whole of the escapement pivots were made to the holes; and, as a rule, all those pivots were burnished, thus it was that the bad effects were seldom seen at the escapement holes. It was the reverse with the train holes, as it was usual for the jeweller to make the holes to the pivots, and they had a system much to be regretted, for, instead of fitting the pivot in a gauge and using a hardened size which corresponded, they used the pivot itself, and thus risked charging it with diamond powder. Whenever this occurred, it was impossible to properly burnish that pivot; in fact, if you want to thicken the oil in the least possible time, charge the pivot. Third condition, it was essential to have proper oil, and to use the best means to keep it at the holes, a good amount of side shake being necessary. Mr. Hux then stated how he came to give his attention to the solid holes, and the satisfactory results from them, and explained the way in which he had fusee holes jewelled, which effectually kept the oil to the pivots and shoulders,—the hollow being cut in the root of the pivot, thus leaving the shoulder on the outside, and having the top side of the ordinary jewel rounded off, and putting that part nearest the shoulder. In conclusion he said, he had simply given the result of his experience, and if he had any preference for one stone over another it was in favour of the sapphire.

Mr. Cole would not refuse the Chairman's summons, but he found little to say after the preceding remarks, which seemed to exhaust the subject, on a first consideration, still he might furnish some experience. He had used the solid jewel holes, those with the hole and end piece in one and the same stone, 25 years ago, and found them to answer well. He thought well of Mr. Hux's suggestion—reversing the stone to the upper fusee hole when jewelled, so as to bring the flat against the shoulder of the pivot; the extra friction so near the motive power would be of little consequence. In order to test the need of oil in an escapement action where a ruby roller was employed in a watch with his double rotary escapement, he set the watch going, the roller being left without oil; on looking at the watch some 10 or 12 hours after, he found the vibration of the balance much diminished; the application of a little oil soon restored it to the normal state. He then substituted a *gold* action on the ruby in place of the steel previously applied, and found, with no oil to the ruby, a diminution of motion at the balance, but to much less extent than in the previous instance, whence he was led to think some electric action was set up in the case of the steel repose arm. His experience of watches jewelled throughout was a very satisfactory result in the time-keeping. On one occasion, however, he made a watch with the escapement jewelled, but he left the train wheels and pivots in the condition received from the movement maker. When the watch was set going, he found the action of escapement and vibration of the balance perfectly satisfactory even under these conditions.

Mr Brooks said, he quite concurred in the remarks as to the necessity of completely finishing the jewel holes before setting them. He knew there were plenty of jewellers who would always furnish good work in all respects if adequately paid; but if that care were not remunerated, they could not expect these results.

Mr. Isaacs explained that his experience was limited in this branch, but he quite agreed that the escapement should be jewelled throughout. He had found much wear in the lower centre holes, which might arise from the general shallowness as usually left. He had been much struck with the sound state of the holes and pivots after many years' wear in some fine old watches he had seen, and asking the reason of this of a workman whose age and long experience would warrant an answer, he was told that the pivots were well turned and polished, and a good amount of side shake was always left, and he thought that the teeth of the wheels to these old watches were more carefully finished than in many modern movements. The absence of this side shake in jewel holes which remained unaltered he thought had much to do with their not giving a good result.

After some observations from Mr. Pinkerton, detailing his experience and an instance of jewelling being removed for metal holes,—

Mr. Jackson replied, observing that the highest theoretical knowledge required practical confirmation. Neither the bell metal for pivot holes, nor the axiom that ruby actions required no oil, being yet proved in practice, though advocated by so distinguished a man as Sir Isaac Newton. But carefully filtered black lead had been used with unqualified success to the pivot of regulators in the place of oil, to reduce friction. The balance of the remarks seemed to him in favour of the view taken by himself, that there was no disadvantage to the time-keeping of watches not to jewel them throughout, even if the only exception to jewelling was the lower great wheel and upper centre and third holes, which no one had advocated jewelling; and the experiment narrated by Mr. Cole of the result of leaving the train arbors unpivoted even, although explained by Mr. Cole as not being a permanent result, but one of a few hours, seemed to him to favour this view.

The Chairman, after some appropriate remarks (in which he said that when he was apprenticed to the Clockmakers' Company he was bound on oath not to divulge any of the secrets of his master, but now a different view seemed to be prevailing, and, as he thought, with good reason), announced the next subject for discussion.

With a vote of thanks to the Chairman, and one to the opener, the meeting then separated.

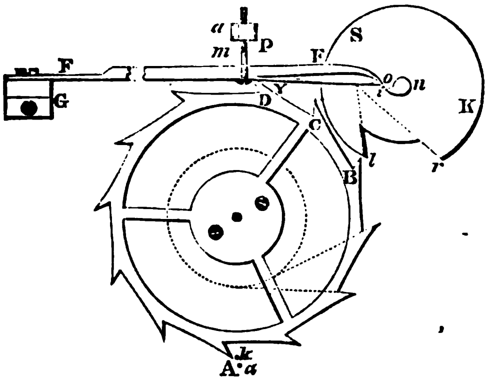
WHAT IS HOROLOGY?

(*Continued from page 33.*)

Earnshaw's Escapement and Balance.

We now proceed to give an account of Mr. Earnshaw's escapement and balance, condensed from his own description as laid before the Board of Longitude on June 7th, 1804.

Fig. 43.



The small wheel, M S K (*fig.* 43), is called the large pallet; it is a cylindrical piece of steel, having a notch or piece cut out of it at *l h r*. Against the side of this notch is a square flat piece of ruby or any hard stone, *k l*, ground and polished very smooth and fixed fast into the pallet. The cylinder is so placed with respect to the balance wheel (escape wheel), that it may not be more than just clear of two adjoining teeth. EF is a long thin spring, which is made fast at one end by being pinned into a stud, G, and made to bear gently against the head of an adjusting screw, *m*; the other end is bent a little into the form of a hook. To this spring is fixed another very slender spring at Y, which projects to a small distance beyond it. This small spring lies on the side of the thick spring nearest the balance wheel (escape wheel). The adjusting screw *m* takes into a small brass cock at *a p*, which is screwed fast to the upper plate by a strong screw. Upon the spring EF there is fixed a semi-cylindrical spring, which stands up perpendicularly, and is of a sufficient length to fall between the teeth of the balance wheel (escape wheel) ABCD. This pin is called the locking pallet, and is placed on the opposite side of the spring represented to view. Through the centre of the cylindrical pallet MSK a strong steel axis passes, called the verge; the pallet is made fast to this axis, which also passes through the centre of the balance, and is made fast to it; it has two fine pivots at its extremities, upon which it turns very freely between two firm supporting pieces of brass screwed firmly to the principal plate. A little above the cylindrical pallet M S K is fixed a small cylindrical piece of steel, *i n*, having a small part projecting out at *i*, through which the verge also passes; this is called the lifting pallet, and is from one-half to one-third the diameter of the large pallet; it fixes upon the verge like a collar, and is made fast by a twist, so as to be set in any position with respect to the large pallet MSK. The end EG of the long spring EF being made very slender, if a small force be applied at the point *o* to press that end out from the wheel ABCD, it easily yields in that direction, turning as it were upon a centre at G; it is also made to slide in a groove made in this stud in such a manner that the end *o* may be placed at any required distance from the centre of the verge.

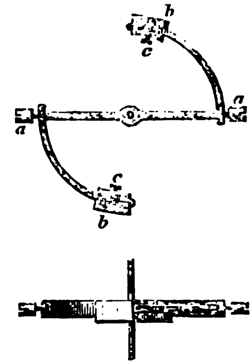
With respect to the situation of these parts in regard to each other, let the long spring EF be supposed to be so placed that the end of the slender spring *i* may project a little way over the point of the lifting pallet *i n*, but not so close but that the point of the pallet may pass by the hooked end of the spring EF without touching it. The head of the adjusting screw *m* is also supposed to bear gently on the inner side of the said spring EF, or that nearest to the wheel, and at the same time the locking pallet is so placed that one of the teeth, D, of the balance wheel may just take hold of it. (This pallet is not visible in its proper place in the figure, being covered from sight by the screw *m* and part of the spring EF; its position is therefore represented by the dot *k* on the opposite side of the wheel, having the tooth A just bearing up against it.)

Now, a force being applied to the balance wheel (escape wheel), so as to cause it to move round in the direction of the letters ABCD, one of the teeth, D, will come against the locking pallet (as shown at A *k*); the wheel is then said to be locked, being prevented from moving forward by the pin. Let the balance be now supposed to rest in its quiescent position and it will have the situation represented in the figure, the lifting point *i* of the pallet *i n* will be just clear of the projecting end of the slender spring, the face *h l* of the large pallet MSK will fall a little below the point of the tooth B, and the balance having a helical spring applied to it remains perfectly at rest in this position. As the balance and the two pallets are fixed fast to the verge, it is plain they must all move together.

Let, therefore, the balance be carried a little way round in the direction of the letters MSK, by this motion the end *i* of the lifting pallet *in* will be brought to press up against the projecting end of the slender spring, and, as this spring is fixed on the side of the spring EF, the point *i* will press the two springs together out from the balance wheel ; then, as only the point of the tooth D touches the locking pallet, when the spring was at rest against the head of the screw *m*, it will, in consequence of the spring having been pressed out, have slipped off ; the wheel being now at liberty will move round by the force applied to it. As the point *i* of the lifting pallet moves on, the point *l* of the large pallet will be got to *d*, and in this position the point of the tooth B will fall upon it, at the same time that the point of the tooth D has dropped off from the locking pallet *m*. The tooth B then gives an impulse to the large pallet, and through it to the balance. In doing so the point moves up towards the bottom of the face of the pallet towards *h*, till the flat surfaces of the tooth and pallet come into contact, by which time the end *o* of the slender spring has dropped from the point of the lifting pallet and the two springs have returned to their quiescent position, the locking pallet in a position to receive the next tooth, C, of the balance wheel. When the two surfaces of the tooth and pallet are thus in contact, the greatest force of the wheel is exerted upon the pallet. The tooth still pressing, and the pallet moving in the direction MSK, it at last drops off, leaving the balance at perfect liberty to move on in the direction in which it was going. As the tooth B leaves the pallet, the tooth C drops on the locking pallet, and the wheel is again locked. The balance moves on till restrained by the pendulum spring, which brings it back again. As it returns the point *i* of the lifting pallet passes the ends of the two springs, and in so doing pushes the end *o* of the slender spring in towards the balance wheel until it has passed it. After this the end *o* returns, and applies itself close to the hooked end of the spring EF, as before. The spring Y *o* is made so slender that it gives but little resistance to the balance, which is at its greatest velocity when the point of the lifting pallet is passing it. The balance now goes on until its motion is again restrained by the pendulum spring, when it again returns, to go through the same series of actions.

Fig. 44 represents Mr. Earnshaw's balance, which, like Mr. Arnold's, has two compensation arcs, but shorter than his. *a a* are the screws for adjustment for rate. The sliding pieces *b b* have each a circular groove turned in a lathe, deep enough to form a bed for the expansion bars, in order that the interior side screws *c* and *c*, may pass against the edge of the expansion pieces and retain the sliding weights in any given position. *Fig.* 45 is a

Figs. 44 *and* 45.



lateral view of this balance without the pivots, which, Mr. Earnshaw says, "should be conical, except very near the ends, which should be cylindrical, and should run in a jewel hole as thin as possible, so as not to endanger cutting the pivot." The sliding pieces are the weights of adjustment for temperature ; their weight was stated at about 20 grains each for a marine chronometer.

In adjusting this balance for position, Mr. Earnshaw speaks of a somewhat curious method of adding weight to the balance. He says, in the first place, that "much difficulty has fallen to the lot of watchmakers in the endeavour to make timekeepers go nearly the same in the different positions. I have had my share of this, but it is now over. By far the greater part of the difficulty arises from the balance spring not being properly made. But if the spring is made as I shall describe hereafter, you have only to make the balance of equal weight, and it will go within a few seconds per day in all positions alike ; and if it vibrates not more than a circle and a quarter, by applying a small matter of weight to that part of the balance which is downward when in the position that it loses most it will correct it in different positions. When asked how he applied this weight, he replied that he fixed on to one of the compensation weights thot was downwards a small piece of brass, not larger in diameter than a pin's head and nearly as thin as foolscap paper. "I fix it on with a *very small portion of bees-wax*." "If the watch is losing, I drill out a small matter from that compensation weight that is uppermost when in the position that the watch loses most." Dr. Pearson remarks upon this, that he was almost induced to examine

whether the balance itself was not fixed to the collet by *bees-wax*, but he recollected two little screw heads on each side the centre which appeared to be intended for that purpose.

Mr. Earnshaw's greatest difficulty seems to have been to find out what he calls the *invisible properties* of the balance spring. By this he appears to mean its effect in acceleration or retardation of rate. To use his own expressions, he found that watch springs "*relax* and *tire* like the human frame." Therefore, finding that isochronal springs would not do, he made them of such a shape as to gain in the short vibrations about five or six seconds a day more than in the long ones, because if equal-timed the piece would *lose* on its rate, and if it gained more in the short vibrations than five or six seconds it would in the long run accelerate its rate. These springs were tapered by hand, and are merely made of hard drawn wire, not being hardened and tempered by heat and cold, that process being thought unnecessarily by Mr. E. Their length varied from 12 to 20 inches, the shape being cylindrical, with the two extreme coils each about half the diameter of the other coils.

Two of Earnshaw's timekeepers, according to Dr. Maskelyne, were tried three several times at the Royal Observatory for a twelvemonth or more together, between 1798 and 1802, as candidates for the rewards offered by the Act of Parliament, but were adjudged not to have gone within any of the limits prescribed by the Act, and therefore were not tried at sea. As, however, they appeared to have gone sufficiently close to be of considerable use in navigation, the Commissioners, in 1803, resolved to grant to Mr. Earnshaw the sum of £2500 in addition to the £500 which they had given him before.

(*To be continued.*)

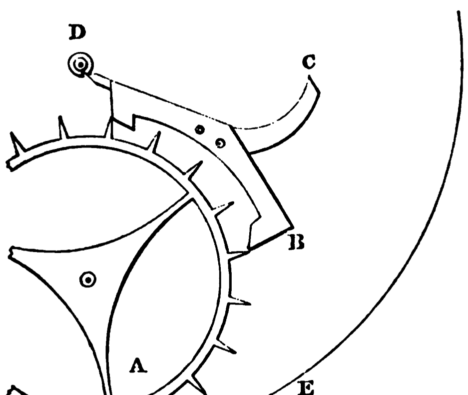
THE ANTI-DETACHED, OR REPELLENT LEVER ESCAPEMENT.

By J. F. Cole.

To the Editor of the Horological Journal.

Sir,—Agreeably with the intimation given by your note in No. 15 of the Horological Journal, I forward you the following briefly repeated description of the principle, in illustration of the subjoined diagram of the same, drawn to a scale of proportion sufficient for the present purpose.

The general outline given in the November number explains the mode of action adopted by me for giving motion to the balance, as by the escape wheel being made to act throughout impulsively on both the respective locking and driving planes of a pair of anchor pallets; such or any other modified form of wheel and pallets being made to communicate motion to the balance, either by means of a simple lever arm attached to the pallets, or by a radial pin inserted into the anchor pallet piece. By either of these or by any other mode of making the lever arm, the acting impulse end of the arm should terminate as a single pointed wedge, or the extremity be otherwise suitably thinned so as to rest or lock upon the outer cylindrical surface of an ordinary duplex ruby-roller fixed on the balance axis, and the end of the arm carefully shortened so as to pass just freely through the roller notch, as stated in the former description. By this arrangement of the roller and lever, the extremity of the arm acting in the roller notch is the only means by which motion is communicated from the wheel and pallets to the balance, without any impulse pallet on the balance axis or other connexion with the motive power from the escape wheel, as shown in the annexed diagram; where A is the escape wheel, B the anchor pallets with repellent lockings, C the lever arm, and D the impulse roller and notch, as fixed on the balance axis; E being the circumference of the balance.



The escape wheel here represented is cut of the simplest form of star-shaped teeth, the acting forward faces of the teeth being sloped as a line to correspond with the repellent locking faces of the anchor pallets when the teeth are resting thereon. The form and direction of the

wheel teeth and other parts of the escapement may be made to differ in some respects, without departure from the fundamental principle of this escapement. Many minor details and modifications will however, doubtless, be hereby suggested to competent watchmakers, but they will be included in the general principle of my invention, and some will be set forth and claimed by me in the complete Specification of the Patent I have secured.

The mechanical properties and advantages of the above described Repellent Lever principle of Escapement consist—

1stly, In its being so constructed, as to prevent entirely the common liability to acceleration on time as a banking error, and also the liability to injury to which ordinary lever pocket watches are subject.

2dly, By reason of the very slight frictional repose of the lever arm on the impulse ruby roller, friction thereon will be more or less intense as the motive power from the mainspring may be greater or less. This principle, therefore, will be of great advantage in compensating for irregularities of motive power, as from imperfect fusee adjustments; but the principle will be of further value in reference to wheel barrel watches, as tending to lessen the variable extent of balance motion to which barrel watches with detached lever or chronometer detached escapements are liable.

3dly, The lever being arrested on the true circular surface of a ruby roller, there is no difference of resistance to the uniform motion of the balance at the point of unlocking, as the action of discharge is, on the contrary, a slight addition to the impulse in both directions; it therefore balances the slight recoil of the lever when the roller notch is passing.

4thly, The principle of the entire action as here employed, being reduced to a condition of extreme simplicity, is more durable, more easily executed, and in no respect likely to be disarranged in the ordinary process of cleaning the watch.

5thly, This escapement is not liable to stop by any checking of the balance momentum through casualties of external motion of the watch, as it will always start into action by the motive power of the mainspring.

6thly, There is no possibility of tripping in the action under any circumstances, and all places of action are well adapted to retain the oil.

7thly, There is less mechanical difficulty, and no increase of manufacturing expense, when produced under proper working arrangements.

JAMES F. COLE.

29, Devonshire-street, Queen-square,
November 21st, 1859.

LE ROY'S PRIZE CHRONOMETER,

WITH A MEMOIR ON THE BEST METHOD OF MEASURING TIME AT SEA.

(*Continued from page* 38.)

ARTICLE IV.

Where we again establish the necessity of giving to the vibrations of the Regulator the greatest possible freedom.

I believe I have already proved (Article II., Part II.) that, to give to a clock the greatest degree of accuracy which it is susceptible of, it is necessary that the vibrations of its regulator should have the most perfect isochronism and the greatest freedom possible. And now that I am going to treat of the escapement (whose disposition must always be relative to nature, and to the properties of the regulator which is used), to leave no obscurity on this capital subject, I think it will be best to examine it a little more in detail.

I acknowledge that in watches, where the very confined space does not permit us to apply all the resources of the art, it would be very difficult to determine whether some slight difference in the times of the long and short vibrations do not sometimes, as well as slight frictions, produce compensations whence results a greater degree of accuracy, or rather less inequalities; but in the present case, where, being master of space, we may use methods less uncertain, it may be demonstrated, and I shall prove, that the isochronism and perfect freedom of the regulator are the only means to obtain a greater degree of truth. *

In effect, friction is a thing subject to a thousand varieties incompatible with much exactness. Let the regulator in its vibrations experience some friction, it necessarily follows that the quantity of this friction will vary according as the contact of the air alters the polish of the rubbing surfaces, according as they alter each other and the softest body leaves its parts on the hardest, according as the oil which we apply to soften the friction becomes more or less fluid, &c.

Let us suppose, also, that the vibrations of the regulator, abandoned to itself, are not isochronous, but that by some mechanical artifice we happen to render them all of equal

* See Graham's Letter to Sully, in the *Description Abregée*, p. 75, Bordeaux, 1726. This work of Sully's is extremely rare even in France. Berthoud was many years before he could procure a copy of it. See Note C, page 15 of his Introduction to the *Traité des Horloges Marines*.—T. S. E.

duration (by friction, for example, or, as this operates in some clocks, by the curves of the anchor escapement, or by that with a double lever, &c.), I maintain that such an isochronism, being subject to a thousand uncertainties, can never give the necessary precision in a timekeeper at sea. In effect, besides the varieties of friction, M. Le Roy* has demonstrated, in treating of the pendulum, that a diminution of the arc of vibration (arising from that of the motive force, from the clogging of the wheels, or from that of the regulator) requires in each of these cases, in order to be compensated, the curves of the anchor to be altogether different, and likewise longer or shorter pallets in the escapement with a double lever. Now, what he has said with regard to the pendulum is evidently applicable here, since we have seen (Article II.) that, supposing the vibrations of the free balance isochronous, in its application to the watch, the long arcs which arise from less friction upon the pivots would make it advance, but if they proceed from an overplus of motive force they retard it, on the contrary; and that the difficulty of the action of the wheel-work would produce again a different effect, &c.

What will it be if we introduce the changes which arise in the magnitude of the vibrations from shocks and divers motions? By a little attention we shall find, that an escapement can never render the vibrations isochronous in these different cases, unless it be a true Proteus, whose form continually varying adapts itself to these different circumstances.

I shall say on this occasion, that, notwithstanding the experiments made with the timekeepers of Mr. Harrison, which are so strongly in favour of this work, the methods which are used to render the vibrations of the regulator isochronous appear to me very imperfect, and that I am here of the same opinion as the person who has made the Report to the Board of Longitude.

"Supposing," says he, "the opinions of Mr. Harrison to be true," (he speaks of the short vibrations, which Mr. Harrison pretends are slower than the long), "I am by no means certain," continues he, "that the methods he employs are proper to produce the effects which he expects from them." In truth, this article of the Report appears to me absolutely unintelligible. "Mr. Harrison uses," says the Report, "two methods to render the motion of the vibrations equal: the first is, to put a pin, against which the balance may press, which augments its force; but it is found to be diminished, as Mr. Harrison pretends, when the vibrations are greater. The second method is, to give to his pallets such a form that the wheels may press them less when the vibrations augment." Although the terms of this Report are not very intelligible, and appear even incomprehensible, since it mentions "wheels" which press less when the vibrations augment, instead of which, by the description, there is a very delicate spring which acts on the balance by one wheel only, we may nevertheless suspect that the isochronism of the vibrations proceeds, in a great measure, from the curve of the escapement; that thus, by what precedes, this isochronism does not appear founded on fixed and invariable principles.

A still more powerful motive to determine us in favour of the isochronism and freedom of the vibrations, as far as it is possible to obtain them, is, that the same obstacles, of whatever nature they may be, arising from the air, or from some slight friction, which oppose themselves to the motion of the regulator, will have so much the less influence on the time of its vibrations as these are more free. This is what it is so important to clear up, and which I shall demonstrate by the following propositions.

Definition.—It is necessary to distinguish two times in the vibrations of a body: that which it employs to overcome the accelerating force, and that where this force restores to it the motion which it has lost. I call that where the accelerating force is surmounted *retarded* semi-vibration, and that where the body returns to its point of rest *accelerated* semi-vibration.

Proposition.—In every body that would make isochronous vibrations when disengaged from foreign obstacles and aided by an accelerated force, the resistance of the air, friction, &c. shortens the time of the retarded semi-vibration.

Suppose that, at the instant when it begins to be retarded, a body, A, has, for example, the requisite velocity to describe a space of 30, but that it only describes one of 20, because the friction which it experiences consumes a part of its motion; it is required to show that A will describe the space 20 with its initial velocity 30 in less time than if, having experienced no resistance foreign to the accelerating force, it had described the same space 20 by means of an initial velocity of 20. The following is the way I prove it.

It is only in the last point of the space 20 that A moves with the same velocity which it would have had in this point if it had only consumed the velocity 20 instead of that of

* See my "Memoir on Clockwork, &c." published in 1750.

30; in the pendulum it has the necessary velocity to overcome the resistance of the accelerating force; in the last it has, besides, that of friction, or the air, which it experiences there; in the antepenultima it has the requisite velocity to surmount the resistance of that same force in the two last *plus* that of the air, friction, &c. Applying the same reasoning to all the other points of the space 20, we shall find that in the present case the velocity there is greater than if, disengaged from every obstacle foreign to the accelerating force, A should describe the space 20 only by means of the initial velocity: the same must be concluded for every other space. Therefore the foreign resistances experienced by a body in vibration shorten the time of the *retarded* semi-vibrations.

Corollary I.—The inverse of the preceding evidently takes place in the *accelerated* semi-vibrations.

Corollary. II.—The obstacles which may be opposed to the motion of a body in its retarded semi-vibration being so many causes which make it stop the sooner; on the contrary, in the accelerated semi-vibrations, the foreign obstacles destroying a part of the acceleration and hindering the semi-vibration from being made so readily (since every body which oscillates necessarily feels some foreign resistance, whether from the air, from the friction of the parts which sustain it, or from the particles themselves of the spring which holds it), it follows that in every body which vibrates the retarded semi-vibration is always quicker than the accelerated semi-vibration which succeeds it; and that the more considerable the resistances are which we have just spoken of, the greater is the difference between the time of the acceleration and the retardation.

Observation 1.—In the vibrations that a body makes by the help of an elastic force or of gravity, if we admit that is the effect of a fluid, a second cause again renders the accelerated semi-vibrations slower than the retarded:—it is in the latter that the active principle, whatever it may be, has always its full effect, whilst in the other it acts only with the excess of velocity which it has on the body when it returns to its point of rest.

Observation 2.—If in the vibrations of a body the difference of time employed for each of the parts which we have distinguished in it is not sensible, the small foreign resistance which may take place will not sensibly alter the time of the whole vibrations; for the retardation which happens in the accelerated semi-vibrations will then be compensated by the gain which they will produce in the retarded semi-vibrations, and *vice versâ*.

Observation 3.—But when several causes render the accelerated semi-vibrations sensibly slower than the retarded, then the whole vibrations are considerably retarded by the new resistances which take place; for, 1st, In the accelerated semi-vibrations the body having less velocity than in the retarded of the same magnitude, the force which it has to overcome the new obstacles which are opposed to it is so much the less; 2dly, We have seen that the resistances produce always in a body in motion obstacles proportional to the time that it remains exposed to them; these obstacles are therefore more considerable in the accelerated semi-vibrations than in the retarded, consequently the retardation which they produce in the former is greater than the advancement which they occasion in the latter, and this retardation follows the ratio of the square of the difference of times employed in each of the accelerated and retarded semi-vibrations.

Corollary III.—Hence we see, 1st, That foreign resistances necessarily tend to destroy some little of the isochronism of the vibrations of a body, and to render them slower, at the same time that they diminish their extent. This is what the experiment proved to us, Article II., Part II. 2dly, That the more we reduce the friction of the regulator, the nearer we approach to the compensation of which we have spoken in the second observation. 3dly, That by the preceding we are very distant from this compensation in common watches with a dead escapement.

Article V.

Description of the Escapement of the New Watch, which preserves isochronsim in the Regulator, and freedom in its vibrations.

All that precedes proves to us that the best, the most certain, and even the only method of bringing a marine clock to the requisite degree of truth, is, as has been said, to render the vibrations of its regulator as free and as isochronous as possible.* This is what I have followed. It has been seen in what manner I have arrived at it,—by the suspension of the regulator. But, to preserve to it this freedom, so precious in its application to the wheel work, it is necessary to employ an escapement totally different from those which have hitherto been made.

Of what use would it have been, in effect, to have annihilated friction in the suspension if by the nature of the escapement the regulator had met with twenty times as much?

* I cannot here agree in opinion with Daniel Bernoulli, who recommends (*ibidem, p.* 43) to augment purposely the resistance of the air to the motion of the balance, and to add to it three or four wings.

This is what would have happened if I had had recourse to the cylinder, or to other dead escapements, which in the end amount to the same as this first, the friction being always very much increased. I dare affirm that it was, in a great measure, on account of the escapement that most of the attempts to discover the longitude by clock work have miscarried. We may consult on this subject the remarks made by Sully on marine clocks.

The following is an experiment which will show how considerable the friction is even in the best escapements. I took a cylinder watch by Mr. Graham, and turned the ferule of the spiral in such a manner that the points of the wheel, instead of corresponding to the lips of the cylinder, fell in the middle of the cylindric portion where the dead part takes place; I then moved the balance, whose axis was vertical, from its point of rest by an arc of about 80°. It only remained in vibration four seconds and a half; instead of which, when it was free on its pivots, it vibrated a minute and a half.

To avoid this inconvenience of the best known escapements, I have used in the new watch an escapement nearly similar in its principle to that with a detent, which is the invention of M. Le Roy, and described in the History of the Academy for the year 1748.* The balance wheel *r* (Plate I. *fig.* 7, and Plate III.), whose teeth are very wide apart and very slight, and consequently whose strength is very small, its power consisting in the length of the lever on which it acts; the balance wheel, I say, by means of the pallet *p*, adapted to the circumference of the balance (Plate III. *figs.* 1, 2, and 3), restores to it, every second vibration, the motion which it loses; and its action is suspended in these vibrations by an obstacle foreign to this regulator, that is to say, by a sort of detent, D, *e*, H, C, F, (*figs.* 2, 3, and 5, Plate III.)†. The following is the way in which it is done.

The balance stopped by the detent at D, as in *fig.* 2, Plate III., on the balance turning on its axis from *i* to A, after having surmounted the spiral springs and consumed its force, these springs bring it back, and make it turn from A to *i*. In this return, by means of a pin situated on its upper plane at *i*, the balance pushes the arm of the lever F H, and consequently draws out the arm D H of the detent from the circumference of the wheel and makes the arm *e* H enter, on which the following radius K *r* of the wheel rests: this is what I call the preparation, and it is represented in *fig.* 3. In the following vibration the balance wheel restores the motion to the balance by means of the pallet *p*, in the following manner:—A pin situated as the preceding, but on the lower plane of the balance, pushing the arm of the lever *e* H, draws out the arm *e* H of the anchor from the circumference of the wheel, and makes D H enter; and when the pallet *p* has arrived at F, then, the wheel being free, the radius F *r* (*fig.* 1) restores to the balance its lost motion, and pushes the pallet *p* until it is stopped by the arm D of the detent, &c., as in *fig.* 2. By this construction, with the exception of the very small arc employed for the disengagement of the detent, and the pulsion of the balance wheel, the vibrations of the balance are absolutely free, and disengaged from all friction on the part of this wheel, stayed, as I have said, on an obstacle absolutely foreign to the regulator; and as the disengagement of the detent, and the restoration of motion by the wheel, are executed about the middle of the arcs of vibration, where the regulator has arrived at its greatest velocity, the very slight obstacle which this detent causes, &c, becomes yet much smaller: the obstacles of friction, of cohesion, like those of gravity, are proportional, as has been said, to the time during which the body surmounts them.

I shall add to this description, that, to hinder the detent from getting out of its place by any great shock, I have placed in the circumference of the balance, near each pin which removes the detent, a portion of a circle *i* A, A *i* (*fig.* 1, 2, and 3, Plate III.), which the corresponding arm of this detent, nevertheless, can never touch, except in cases of the most violent shocks.

(*To be continued*)

* This is the first work that I published.

† This detent forms a kind of escapement which may be varied at pleasure, using indifferently that of Graham Aman, Sully, &c.

LITTLE BELLS.

To the Editor of the Horological Journal.

Sir,—As you have introduced the Great Bells in a recent number, perhaps you may find a corner for a few little ones, as an echo to their overgrown brethren.

The sound of bells very evidently depends a great deal on the construction of the spire or steeple, as the sombrous tone of those in massy-built towers without steeples may very amply testify.

At Hinckley Church, in Leicestershire, a very ancient edifice, the spire steeple is sufficiently spacious to admit of two sets of

bells; the ring of five are melodious, and another set for a chime was completed in the year 1778.

At Boston Church in Lincolnshire, built as farb ack as the reign of Edward the Second—and the largest church in the kingdom without cross aisles—the tower is modelled from the cathedral of Nôtre Dame at Antwerp, and admiraly designed for a ring of bells, as its prototype can very justly demonstrate, and the bells in that tower speak music.

The town of Newark, in Nottinghamshire, is graced by a very ancient church of the Sixth Henry, and the beauty of the steeple, so much admired for its symmetry and lightness, is heightened in the estimation of the beholder when the exhilarating sound of the harmonizing chorus of the eight bells falls so cheerily on his hearing.

The picturesque town of Ludlow, in Shropshire, has a church with a lofty tower in the centre, noted for a fine peal of eight bells.

The Temple Church at Bristol (originally called Holy Cross) is remarkable for its high and elegant tower, which, leaning towards the street, is many degrees out of the perpendicular (some say five or six feet); and when the bells are rung, it moves, as Camden asserts, "*huc et illuc*," this way and that. This tower is often compared for its elegance and height with that of St. Martin the Less, at Cologne.

The modern Christ Church in Bristol is also justly celebrated for its peal of ten bells.

With respect to the churches of London and its suburbs, the splendid steeple of St. Martin-in-the-fields is acknowledged to contain the best set of bells in the metropolis; though, no doubt, for the mellowness of sound some would prefer the legendary peal at Bow Church, Cheapside, with the tower and spire by Sir Christopher Wren.

Christ Church, Spital-fields; St. Leonard's, Shoreditch; and St. Bride's Fleet street (another of Sir Christopher's), have all towers and spires admirably adapted for the sound of bells,—an object well worthy the notice of architects.

Our friends on the other side of the Tweed do not appear to be over-enamoured of bell-ringing, though there is a peal in a tower at the Trongate in Glasgow, that are incessantly clanking in a tone that falls on the ear very much like the sound of marrow-bones and cleavers.

There is a language in the sound of a fine peal of bells that can only be interpreted by connoisseurs in the art, but even to the uninitiated it is one of a singular and mysterious interest. I recollect, on one winter *evening, forty years* ago, when on the road from Stow-on-the-Wold to Stratford-on-Avon, at the distance of six miles from the latter town, the sound of church bells fell on my hearing, which continued during the entire journey, and the spell of enchantment conveyed in the undulating harmony wrought in my senses the creation of a spiritual dream, although I am willing to confess that the shades of the great poet might have had a share in the inspiration.

ANTIQUARIAN.

REID'S TREATISE.

To the Editor of the Horological Journal.

Sir,—I observe that, in your replies to enquirers, you state that *Reid's Treatise* appeared in 1826. Allow me to state my belief, that the words in that treatise are identical with the articles inserted and published in Chambers's Encyclopædia and Rees's Supplement in 1791; because I know that an attempt was made in the year 1825 to obtain subscribers for the express purpose of publishing the said articles in one book, it being well known that the whole of them were written by Mr. Thomas Reid, Watchmaker, in Edinburgh. Subsequent editions have been printed, and a considerable number of plates have been added. My object, therefore, is to shew that the age of the work would warrant an attempt of one of the present generation to add to that work an addenda of all the improvements which have taken place in our manufacture during the last sixty-eight years, for in 1825 much objection was raised to subscriptions on account of the absence of the Detached Lever Escapement, &c.

JAMES STODDART.

[The want expressed by our correspondent will shortly be supplied, we think, as may be seen by reference to Mr. J. F. Cole's advertisement in our last page.—ED. H. J.]

THE IMPERIAL STANDARD YARD.

To the Editor of the Horological Journal.

Sir,—The act of 6 Geo. IV., cap 74, fixes the standard yard measure, and explains the mode of its verification. Thus sec. 3 of the above act runs,—

"And whereas it is expedient that this standard yard, if lost, destroyed, defaced, or otherwise injured, should be restored of the same length by reference to some invariable natural standard; and whereas it has been ascertained by the Commissioners appointed by his Majesty to inquire into the subject of weights and measures, that the same yard hereby declared to be the Imperial Standard Yard, when compared with a pendulum vibrating seconds of mean time in the latitude of London, in a vacuum at the level of the sea, is in the proportion of 36 inches to 39 inches

hundred and ninety-three inch," &c.

As no pendulum vibrates in a true defined arc of vibra- n you inform me whether ;finition of a yard is capable 'erification. Your's, &c.

338, Strand. J. Jones.

OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

Printed by order of the Commissioners of Patents, and t Seal Patent Office, 25,

page 46.)

MARSH, describes his invention: "The wheel of brass "or steel, with a broad edge and the " with a ; when "so cut, to have one or more for the "pinion to vibrate free in ; the " other set of teeth sloped "off to a point, suitable to lock on a pallet or pass though the notch of a roller."

[Printed. 3*d*. See Repertory of Arts, vol. 21 (*second series*,) p. 9; and Rolls Chapel Reports, 8th Report, p. 88.]

1812, April 30.—No. 3559.

MASSEY, in making time-pieces so as to while the pallet wheel, pallets, and balance and in reducing the friction on the verge pallets, by the balance having about of its weight suspended by a thread, passing over a pulley, and a weight being attached to the other end.

[Printed, 6*d*. See Repertory of Arts, vol. 32 (*second series*,) p. 136; and Rolls Chapel Reports, 8th Report, p. 92.]

1812, July 16.—No. 3584.

TOBIAS Inven- " of the move- " graduating, " the dial, as to divide time in the "same manner as seamen and "sea by means for "the on "deck." The dial has three circles; one divided into 30 equal parts answering to minutes; another divided into or bells, and and the third divided to hours, VIII, X, XII. Two indices serve circles. A larger sort may be made with a third index, to show the seconds.

[Printed, 6*d*. See Rolls Chapel Reports, 8th Report, p. 93.]

(*To be continued.*)

EQUATION OF TIME TABLE

For

TO CORRESPONDENTS, &c.

In accordance with the wishes of numerous sub- Journal at the ; henceforward it can be sent per post with the same privilege as a registered newspaper.

communication respecting the and pinions, in which he concurs of H. Delolme's reference to Berthoud. This notice of it, we think, will answer all the objects of his letter.

☞ *We wish it to be distinctly understood that we are not in any way responsible for the views taken by our Correspondents.*

N.B. All Advertisements to be inserted in the Journal must be received before the 25th of the month.

TO MEMBERS OF THE BRITISH HOROLOGICAL INSTITUTE.

THE HALF-YEARLY MEETING of the MEMBERS will be held at the Institute, 35, Northampton Square, on WEDNESDAY, DECEMBER 21, to receive the Report for the last Half-year, and to elect Officers.

NOW READY.

THE FIRST VOLUME of the HOROLOGICAL JOURNAL, containing Papers and Correspondence on the following important subjects:

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THEORETICAL AND PRACTICAL.

BY JAMES FERGUSON COLE.

PROSPECTUS of PAPERS, in Twelve Sections, on the above subject, proposed to be Published by Subscription.

CONTENTS.

Paper No. 1.—Introductory Observations on the general Principles and Construction of Chronometers, Pocket Watches, and other Timekeepers, containing also a description of the principles of the Detached Lever Escapement, (from which the Horological Lecture delivered June 7th, 1859, was chiefly extracted); together with Rules for finding the proper proportions and places of the respective parts of the Escapement, with the usual mode, and an original principle of determining the value of pallet angles for any required arc of motion.

Paper No. 2.—Notes in reference to Paper No. 1.

Paper No. 3.—Description of the principles of the Resilient Lever Escapement in various modes of adaptation, as a remedy for the banking error of Lever Pocket Watches.

Paper No. 4.—Description of the Chronometer Detached Escapement in its usual form, and with an improved arrangement of the locking and discharging springs.

Paper No. 5.—Description of a Chronometer Detached Escapement with compulsatory locking.

Paper No. 6.—Description of an original principle of Chronometer Detached Escapement with rotary lockings.

Paper No. 7.—Description of a Chronometer Detached Escapement with abutment lockings.

Paper No. 8.—Description of the Duplex Escapement.

Paper No. 9.—Description of Double Rotary or Non-Repetition Escapements, for preventing the detrimental effects of external motion on Chronometers and Duplex Watches.

Paper No. 10.—On the principles of the Chronometer Balance in its usual form, with the usual mode of adjustment for temperature and positions.

Paper No. 11.—Observations referring to other principles of Compensation.

Paper No. 12.—On the isochronal principles of the Balance Spring, with theoretical observations and practical rules for isochronal adjustments.

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Orders may be forwarded to the Author, at 29, Devonshire-street, Queen-square, Bloomsbury; and also, by permission, a List for the reception of Subscribers' names and Addresses is placed in the Office of the British Horological Institute, 35, Northampton-square, E. C.

London, June 27th, 1859.

The following are a few of the names of Subscribers already received:—

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The Rev. Wm. Bentinck Hawkins, M.A., F.R.S.
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London: Printed for THE BRITISH HOROLOGICAL INSTITUTE, by R. MACDONALD, 30, Great Sutton Street, Clerkenwell; and Published by KENT & Co., 51, Paternoster Row.

The Journal may also be had at the following Watch Tool Warehouses:—E. J. Thompson, 5 & 6, Percival-street; Grimshaw, 159, Goswell-street; Potter, 12, Upper Ashby-street; Lowther, Red Lion-street; Marsh, Gloucester-street; Greenhill, Sutton-street, all in Clerkenwell; also at E. Hunt, Ironmonger-street, and Houghton, John's-row, in St.-Luke's; at Delolme's, Rathbone-place; Mull, 1, King-street, Soho; Ehuhuus, 53, Frith-street, Soho-square; W. H. Knight, 13, Powell-street; Rees, 1, Crow lane, Coventry; H. Nicholls, 5, Hunter-street, Liverpool; and of all Booksellers in Town and Country.

THE BRITISH HOROLOGICAL INSTITUTE.

HALF-YEARLY GENERAL MEETING.

THE Half-yearly General Meeting of Members was held at the Institute, Northampton-square, on Wednesday evening the 21st of December; Mr. JAMES STODDART, one of the Vice-presidents, in the Chair.

The CHAIRMAN stated, that the object of the meeting was to receive the Report of the Council, with an audited Balance-sheet, for the past half-year; to confirm the election of Fourteen Members nominated for the Council; and to elect two or more Auditors by show of hands; also, to take into consideration the notice of motion to alter the rate of subscription of the Country Members.

Messrs. W. T. Holdstock, F. Clifton, T. J. Hux, and E. J. Bishopp, were appointed Scrutineers of the votes to be given at the ballot.

Mr. G. E. MYLNE, Honorary Secretary, then read the Half-yearly Report, as follows:—

"REPORT OF THE COUNCIL OF THE BRITISH HOROLOGICAL INSTITUTE, FOR THE HALF-YEAR ENDING 16TH DECEMBER, 1859.

"In presenting the Report of the past half-year, with an audited Financial Statement, in accordance with the laws, your Council have again to congratulate the members on the highly satisfactory progress made during the above period.

"They believe, from the many who have joined, comprising influential manufacturers, active members of the numerous departments of the trade, and eminent horologists in France and Switzerland, that the objects and purposes of the Institute, which was established for the mutual instruction and advantage of all concerned in the trade, are now more fully understood and rightly appreciated.

"The number of Members at present amounts to 268; (consisting of 4 Trustees, 15 Life Members, 244 Annual and Half-yearly Members, and 5 Junior Members); of whom one Founder, one Life Member, and 99 Annual and Half-yearly Members have joined since the last meeting in June.

"The *Horological Journal*, which has been registered for transmission abroad, continues steadily to improve; financially it exceeds our anticipations; and we have to express our thanks to the members who have so ably assisted in raising it to its present high position.

"The proceedings of the past half-year commenced by VALENTINE KNIGHT, Esq. accepting the office of President, and the Institute has derived important advantages from such a zealous and influential member.

"Tables of the Rates of Chronometers, from 1841 to 1859 inclusive, have been presented to the Institute by the Astronomer Royal, and will be found valuable for reference. Three transferable Tickets have been received from the Society of Arts, admitting members of our Institute to all ir ordinary Meetings during this session. ·eral valuable Models and Designs have also n presented to the Institute by Members. · such acts of kindness we have to express our nks.

' The Meetings for discussing subjects of in-:st to the Trade have commenced, and your ıncil feel confident that they will be the means :liciting much valuable information. An excel-: Lecture, "*On the Chronometer and its iustments,*" has been given by Mr. SAMUEL Y, which was numerously attended.

A proposition has been made by Mr. RD. R. x, for the consideration of the Members, which met with the approval of the Council, to set rt, in the names of Three Members of the ıncil, Ten per cent of all moneys received from after the 24th of June, 1859, to form a fund, ıe named "The Institute College Fund," and ısted from time to time so as to bear interest; a fund to be for the special object of enabling Council in a few years to purchase premises the use of the Institute.

The Council have agreed to promote the pro-tion by the Trade of a superior lower-priced going-barrel lever watch, to suit the large increasing demand made by the public for ı watches, by offering a prize or gold medal ny one who shall make the best model "English ng-Barrel Watch," both in construction and roved calibre, the copyright of such model ch to be the property of the Institute, and for advantage of its Members; and that a Special -Committee be appointed to make the neces-' arrangements; the funds for such prize or al, and the expenses connected with it, to be ed by subscription from among the Members he Institute.

We cannot conclude our Report better ı in the words of the report in the *Isling. Gazette* of the 17th instant:—'We re-l the Institute, therefore, as a most valuable ne of social advancement; for any contrivance vhich the sordid pursuit of the trade for mere d and clothes and house-gear can be ex-ıged for a generous and intellectual rivalry in attainment of skill and success for their own ·, does more to raise the individual character, the general tone of artisan intelligence, than y an organization of much greater preten-ı.'"

he Honorary Secretary then read the ınce Sheet, which showed Receipts from nders' and other Donations, £13. 15s. 6d.; Members, £5. 5s.; Annual and Half-yearly scriptions, £104. 4s.; Sale of Journals and luce of Advertisements in ditto, £26. 8s. 10d.; of Lecture Cards, £1. 17s. 7½d.; Rent from Palmer, £10; which, with the Balance in Treasurer's hands on August 15th, 1859,

£63. 10s. 5½d., and Interest on ditto, £1. 11s. 9½d. made a Total of £226. 13s. 2½d. The Payments were £179. 9s. 4½d.; leaving a Balance, £47. 3s. 10d.

Mr. CROOK moved, and Mr. CLIFTON seconded the adoption of the Report; which was carried unanimously.

The Honorary Secretary read to the Meeting the names of the Fourteen Members nominated to fill up the vacancies in the Council; and the same were confirmed unanimously.

Mr. CHARLES GUILLAUME moved a vote of thanks to the President, Vice-Presidents, Trustees, the Treasurer, and the Council; which was seconded by Mr. HOLDSTOCK, and carried.

A vote of thanks was proposed to Messrs. B. MARRIOTT and G. E. MYLNE, the Honorary Secretaries for the past half-year, and responded to by Mr. MYLNE.

Messrs. J. C. Webb, T. W. Holdstock, and F. Grimshaw, were re-elected Auditors.

The Scrutineers then announced the result of the Ballot for the proposition to reduce the subscription of Country Members as follows:—They had received 51 votes; 38 of which were for Mr. S. A. Brooks's motion, and 13 against it. The Resolution was therefore carried.

The consideration of Mr. HUX's proposition was postponed, the requisite notice not having been given.

Mr. MYLNE proposed a vote of thanks to the Auditors and Scrutineers, to which Mr. Holdstock responded.

Mr. JAS. F. COLE moved a vote of thanks to Mr. JAS. STODDART for his kindness in presiding upon that occasion; who then returned thanks, and the Meeting separated.

THIRD DISCUSSION MEETING.

On Thursday evening, 24th November, the *third* meeting of members for discussion of the questions proposed by the Council and announced in a former number of the Journal took place at the Institute; the subject being "*What advantage has the fusee over the going barrel? and, Is the fusee universally the best for pocket watches?*" when Mr. ADAM THOMPSON, was called upon to take the Chair.

The CHAIRMAN thought that the meeting could hardly come to a conclusion on the subject before it, because as watches differed in size, that which was admirably adapted to one would be inapplicable to another. An arrangement might be good in itself, but wrongly applied. There could be no question about the advantages of the fusee; but it would not do for flat watches.

Mr. J. BENNETT could not refrain from accepting the invitation to be present, and to pay his respects to the Horological Institute. The question involved important considerations, bearing upon the comparative manufacture of foreign and English watches. In the history of the watch they saw that Harrison wanted a motive power for a chronometer, and found it in the very simple form of a ribbon of steel turned up in a spiral shape, and so by its elastic force furnishing a motive power for his machine. Very naturally, with his then knowledge, he determined that it should be of the same thickness from end to end. He put it into a barrel, wound it up spirally over the arbor, and found that it did not exert precisely the same force from top to bottom. To get over that difficulty cost him forty years of study. Then came the fusee, the utility of which nobody would wish to undervalue. Where bulk and cost were of no consideration, they might keep to the fusee; but there were other cases in which these two elements were very important—so much so, that their existence amounted to a prohibition of the manufacture and sale. Such was found to be the case by men whom all horologists held in profound respect for the wisdom and indefatigable ingenuity which they had displayed in the perfection to which they had brought the barrel watch—the great Swiss makers. They found the fusee not adapted for the kind of watches agreeable to modern trade. It might be said that, as a matter of science, for a good watch the fusee could not be done without. The Frenchmen dispensed with it, and put the driving-wheel round the barrel. It was said that the English had the best adjustment; but the French made their mainspring taper from end to end, and that sufficed for the motive power. Men were to be found who would make springs of that quality, capable of being reduced to the nicest adjustment, at a minimum of cost. There were makers who had arranged the adjusting instrument, gauged it in numbers in various decimals, so as to answer the purpose they were intended for, for two francs. Mons. Robert, in his published work, gave the rate of many chronometers to which the strictest possible attention of the Royal Observatory of Paris was applied, and he found that the absence of the fusee was no detriment to their most perfect performance, which was so satisfactory that no captain would ever dare to say that he lost his ship through their errors. He said that the spring must be carefully made, and, although flatness might be an object in a pocket watch, still diameter was not always objectionable; therefore he made his watch of greater diameter, got his barrel in accordance with the diameter, and made his spring of an extra number of turns, so that its action never went from the top to the bottom, but took only the central turns. At a meeting of the Society of Arts they had some chronometer makers, among whom was Mr. Loseby, who declared that he did not care about an exact adjustment of the mainspring. He said, "Give me a proper chronometer escapement, a rightly constructed balance of proper diameter, and a proper pendulum spring, and I will make a bottle jack keep time, whatever the shape of the wheel, the teeth, or the mainspring." It had been somewhere said that the arc of vibration might be 180 degrees, or even as high as 250 degrees of a circle, without being detrimental to an exact performance, even in instruments where

that quality was a *sine quâ non.* He (Mr. B.) had a first-class going-barrel watch; and though he was in the habit of riding with it, on horseback, to and from town in half-an-hour, it had not lost more than fifteen seconds a week, and yet it was a flat pocket watch. There were very few secrets in the watch trade now; the days of art and mystery were gone, and whatever they did was patent to the world. They could have watches so cheap as to be manufactured at a cost of £2, and yet be perfectly satisfactory as timekeepers. Watchmakers in Clerkenwell were wearing those very Swiss watches with going barrels, and that with marvellous results, going within a few seconds a week. He had a high reverence for great authorities, but much more for facts under his eyes—tested, not by one but by a thousand cases—and followed by uniformly satisfactory results. It was the business of watchmakers to produce the best possible article for the minimum amount of cost.

The CHAIRMAN hoped that Mr. Bennett would keep to the question, which was the fusee *versus* the going barrel, and not Swiss *versus* Clerkenwell.

Mr. BENNETT, to satisfy the Chairman, would call the respective watches not Swiss and English, but fusee and going-barrel if there was any difference; he took it to be they were both alike. From the returns it appeared that the largest number manufactured with the fusee was in 1855, which, according to the authority of Goldsmiths' Hall, was 186,000 against 1,500,000 made the same year in the south of Switzerland, in addition to large numbers made at Besançon, Copenhagen, and elsewhere. What did the English buyers take of those watches? In the year 1853, 42,480; in 1855, 79,209; in 1856, 90,670. That by no means comprised the total number of going-barrel watches brought in during that period, for many were smuggled by the wealthy classes without any compunction whatever.

The CHAIRMAN reminded the speaker that they were there not upon the commercial, but the manufacturing view of the question.

Mr. BENNETT was endeavouring to show the advantages of the going-barrel over the fusee—first on mechanical, and next on commercial grounds. As a producer and distributor of watches, upon the principle *Qui facit per alium facit per se*, he had a strong interest in the condition of the manufacturers of Clerkenwell; and, upon commercial principles, he must give his voice in favour of the more simple form of the going-barrel. One of its advantages was its simplicity of construction. When flatness was the great object, the chain had to be reduced to such dimensions that it was constantly liable to breakage, and by dispensing with it that liability was reduced. That was of little consequence where a watchmaker was at hand; but if they sought customers from all parts of the world, it was of importance that the watch should be as invulnerable as possible. Another advantage of the going-barrel was its cheapness of production. He had no doubt that it could be well made with tapered main-spring, star wheel, and finger stop, at a cost of 1*s*. He had seen a movement made entire for 7½*d*., and which could be produced by millions at that price; and therefore it was quite reasonable to suppose that the barrel and spring could be done for 1*s*. By and by they would come not only to what to make, but how to make it. Female hands might make them at a price so low that the English would have to fear no rivals on the continent. Reducing the cost of manufacture was the only way of arresting the downward course of the trade, which became more and more difficult to stop. The public looked to simplicity and cheapness. Their grandfathers had the whole trade in their hands, and those who came after them might have kept it had they attended to form and cheapness. For second and third class watches, he (Mr. B) would venture to give his vote in favour of the universal adoption of the going-barrel.

Mr. COLE expressed himself at a loss to understand Mr. Bennett's assertion, that the power from a wheel barrel mainspring could be adjusted, as Mr. B. stated was done to perfection in foreign watches, by tapering the spring thinner from the inner to the outer end, the thicker end being coiled on the barrel arbor at the centre of the barrel. He could not conceive it possible that the unequal power of a mainspring was adjustible by any more simple means than the fusee and chain, as confirmed by long experience; and he believed that no practical watchmaker would deny the fact, that on testing any simple barrel mainspring by fixing the adjusting rod direct on the barrel arbor, every turn of the arbor would raise the tension of the spring higher, by the additional force necessary for overcoming the increasing resistance of each turn in succession, and hence the defect of adjustment. In ordinary fusee watches nearly one-fourth of the height of the movement was lost, it being taken up by the motion work. As a remedy for this objection, and for admitting a stronger chain in flat movements, Mr. Mylne about 17 years ago took out a patent for an inverted fusee. Flat watches with the inverted fusee were also made by Mr. Cole 30 years ago; one of these was now in his possession. In regard to wheel barrel watches, he considered that the successful use of the going-barrel principle had depended materially on the frictional property of the horizontal escapement generally employed in such watches by foreign manufacturers, and was of opinion that the greater freedom of the detached lever escapement and the chronometer detached escapement rendered both these principles more liable to a variable extent of vibration from irregularities of motive power. Watchmakers formerly employed the old verge escapement, which is subject to extreme variation from irregular force; but, notwithstanding this, the care observed in making the fusee adjustment correct, rendered the performance satisfactory. Even a defective principle like the vertical escapement would perform with tolerable correctness if the conditions of uniform power and equal temperature could be preserved. He might mention also, in reference to going-barrel watches, that many years ago he constructed a simplified plan of the barrel work, originating in the adaptation of a screw cut upon the axis of the barrel arbor. This part of the improvement was a suggestion by his brother, Mr. Thomas Cole. The screw on the axis suggested to himself a further improvement, of suspending the barrel work to the frame with-

out any other screws or bar, and economizing that portion of the work; the original model of this was also in his possession. The plan of this suspension of the barrel arbor was by the addition of a double-necked collar fitted on the round axis of the ratchet-arbor, the barrel arbor being the nut which braced the whole together, leaving the barrel perfectly free.

Mr. JONES said that Mr. Bennett's reference to Loseby's remarks at the Society of Arts did not bear on the question of going-barrels, for Mr. Loseby referred to detached escapements with isochronal springs; nor did Mr. Bennett's reference to the accuracy of a foreign watch week by week, or day by day, pertain to the question, for the comparison was between hours, which the question involved. But though Mr. Bennett's illustrations were invalid, he (Mr. J.) thought that that gentleman's advocacy of going-barrels was in some measure correct. He (Mr. J.) had made six watches for the purpose of trying their respective merits, and found that the going-barrels gained the first twelve hours a quarter of a minute as compared with the last twelve hours, which he considered correct enough for common use. The cost, however, was so near that of the fusee work, that he did not continue the manufacture, especially since less power was obtainable as well as irregular time. Mr. Cole's remarks with reference to the equal additions of weights in winding up a spring, giving equal spaces for the revolution of the barrel—or, in other words, equal additions of force giving equal increase of tension—was a surprising yet long-known property of springs, for it was the basis of the principle of the isochronism which Dr. Hook first published in his "Cutlerian Lectures" at Gresham College.

Mr. CONNELL expressed his surprise at the tone the discussion had taken. In a Horological Institute he had imagined that the mechanical features of the question would be the first taken into consideration. With regard to the chronometer, there could be no doubt that the fusee gave a power which made it far preferable to the going barrel. He was surprised at Mr. Bennett's illustration, because, although the Frenchman had endeavoured to show you that a good performance might be got out of a chronometer from a going barrel, still he (Mr. C.) must bring his experience in opposition to what had been published by that author. He had endeavoured to obtain a proper adjustment for the mainspring; and although he was ready to admit that the performance of the mainspring might approach somewhat near to adjustment, yet a perfect adjustment could never be attained without a fusee. Then came another consideration—whether, in making a watch for ordinary wear, a perfect adjustment was absolutely necessary? He thought it was not. He quite agreed with what had fallen from Mr. Jones, that if a watch with a going barrel was tested hour by hour, a variation would probably be found every hour; but he (Mr. C.) looked forward to the day when ordinary watches would have the isochronal pendulum spring. If isochronism could be had in a chronometer, it was only a want of knowledge, and not a want of principle, that prevented the attainment of it in an ordinary watch. When the isochronal spring could be made as cheaply as the ordinary one, then the greatest difficulty of the going barrel would be overcome, and the necessity of the fusee would be obviated. He must say that he was surprised to hear a man of the scientific attainments of Mr. Cole say that good results could be obtained from a bad principle.

Mr. COLE explained that Mr. Connell had mistaken his words.

Mr. CONNELL believed that the time would arrive when they would be able to sell cheaply a steel isochronal pendulum spring, and then the fusee might be done away with. He thought that they would all admit that for perfect timekeeping they must get the greatest simplicity they could obtain. There was greater simplicity in the going-barrel than in the fusee; so that unless some very great advantages could be shown to result from the latter, the English manufacturers would be unwise if they did not adopt the going-barrel. Although it had been said that with a free escapement like the detached lever a good performance could not be obtained with the going-barrel, he must say that he had manufactured many of such watches, which did not at all carry out that view of the question. It was a principle admitted by all, that what had been done could be done again; and that when the principle was thoroughly understood, it would be carried out in every watch manufacture. He only advocated the going-barrel because it was the means, first of cheapening the watch, and then of enabling the makers to produce it suitable to the large mass of wearers. Although he did not desire to make the discussion turn upon the relative number of English and foreign watches respectively manufactured, still, as a seller of the article to the public, he must call the attention of the trade to the fact that he was under the necessity, against his will and inclination as an English watchmaker, of selling Swiss watches to the public, because there was not produced in England the article which they required. As an Englishman, he would much rather use the work of his own countrymen, if they would make what the public demanded. The advantages and disadvantages of the fusee was a question well worthy of the attention of the Horological Institute. The disadvantage of the fusee was nothing when the watch was made to take plenty of room for the chain; but when space was a consideration, even with the inverted fusee to which Mr. Cole had alluded, it could not be done. In thin watches the chain would break very frequently, and the expense of making the fusee was great. There was another portion of the watch which had not entered into the discussion at all, and that was the going fusee part of it, because when they had a going barrel they had a going fusee in itself—at least they had a maintaining power, which was the same thing. When they had a watch with a fusee, they necessarily must have an escapement and a maintaining power, which not only took up a great deal of space, but involved much expense; and when they came to consider that by the going-barrel they got rid of the fusee, chain, and maintaining wheel, the maintaining spring, the detent and detent spring, those were considerations which should commend themselves to persons desirous of making the watch a simple instrument. As the result of his experience, he could state that for the class of watches re-

quired by the public, notwithstanding theoretically the fusee had large advantages over the going barrel, still in practice they were quite counteracted by the considerations he had imperfectly set before the meeting. He was bound, therefore, to admit that, for the ordinary class of watches required by the public, the time had come when the English watchmakers and the manufacturers of Clerkenwell would do well to adopt the going-barrel in opposition to the fusee.

Mr. JACKSON thought this question, (having occupied all the time nearly allowed before the reply, and as none could otherwise offer their experience on this subject) was of that interest to warrant an adjournment. But this not being supported, he proceeded to say, he would condense his few remarks, and not quit the subject to wander into the more exciting theme of the opener,—Swiss *versus* English work; and for this reason, that it was anticipating, if not trenching upon the matter of the next question, to be opened by Mr. Jones. He had made watches with going barrels for several years, and he thought that their application to the lever escapement was not so easily done, with successful results, as Mr. Connell said he found to be the case, and for this reason:—If, in the mere difference of position in a watch with the free escapement, between suspension and the horizontal, or where the pivots are acting on their ends, a difference of vibration was observable in the balance, equal often to three-eighths of a turn, how much more will be the effect of the action of the mainspring in the difference between the first and last turns on the balance and its regulator, the timing spring? Mr. Cole had clearly stated that with increased tension came increased force. In an observation made this day, under favourable circumstances for the going barrel, this effect was well illustrated. Taking a barrel making over six turns, the four middle turns of which were only in action, the first being set up and the last not used, the extreme force, as shown by an adjusting rod, was tried. The last or weakest turn lifted, at 2¼ inches from the arbor, a weight equal to 6 dwt. 5 grs.; while the first, or strongest, lifted a weight nearly double—viz., 13 dwt. less 8 grs. This difference must tell at the balance of a detached escapement. Desirous to know the result in timekeeping, he had compared the going of three eight-day lever clocks made with going barrels, the long trial being a severer test. Going under similar conditions, and furnished with a timing spring of the ordinary kind, they all exhibited a slight gain in mean time for the first day. They then lost gradually, till the daily loss on the eighth day amounted to from 100 to 125 seconds each per day. The opener had succeeded, he thought, in showing that the going barrel was more suitable for flat watches, but had failed in substantiating its claim for use in a superior timekeeper.

Mr. BENNETT said, in reply, he had little to say, as he considered they were all much of one mind, but would like to have the opinion of the meeting taken as he thought the verdict of that Institute would be regarded as a dictum of importance.

The CHAIRMAN, in a happy illustration, explained that they were not there to promulgate a fiat, but to discuss in a friendly way the relative merits of constructive principles. It was clear that all who wished for a superior timekeeper would use the equalizing power of the fusee; while those who followed the fashion, and made flat watches, would employ a going barrel and low numbered pinions.

After a vote of thanks to the Chairman and opener, the meeting adjourned.

WHAT IS HOROLOGY?

(Continued from page 53.)

CONCLUSION.

But little alteration has taken place in the main features of the construction of chronometers since the days of Arnold and Earnshaw. Details may have been perfected, and on the whole as well as in particular cases a greater degree of excellence in finishing these details may have been attained, but a chronometer of the present day is made, as to balance, escapement, and movement, pretty much like those which we have briefly described. There remains but one modification to notice, arising from a curious defect which has been observed in the performance of the ordinary compensation balance. A timekeeper which has been closely adjusted to an equal rate in medium temperatures will be found to lose on that rate in extremes of either heat or cold. Thus a chronometer adjusted for temperature in England will be found to gain less or lose more if sent either to the polar regions or to the tropics. This arises from the fact that the tension of the spring follows a different law in its alteration by temperature to that which governs the alteration of the inertia of the balance under similar circumstances.

As we write for those who are seeking information, it is desirable to explain how this happens.

Fig. 46.

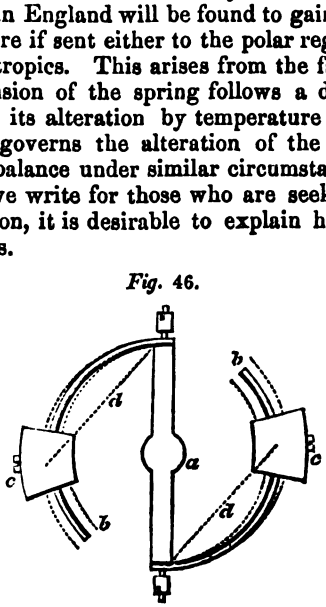


Fig. 46 is an ordinary compensation balance; *b b* are the segments of brass and steel forming the rim, the brass being outside and steel inside; *c c* are the compensation weights.

On an increase of temperature, the ends of the segments approach the centre of motion, as shown by the inner dotted curve lines; and the reverse takes place on a decrease of temperature. In order that the inertia may correspond with the tension in all temperatures, the compensation weights should approach the centre of the balance with an accelerated motion in heat, and recede with a retarded motion in cold. Reference to the figure will shew that the action of the ordinary balance is directly opposed to this requirement. The extremities (or indeed any part) of the curve moves in a spiral direction; and if we connect the centre of gravity of the compensation weight with the junction of the arc with the arm of the balance by the dotted line *d*, the result will be, that a decrease of temperature causing the brass to contract more than the steel, throws out the arc and increases the distance between the junction of the arc and the centre of the compensation weight by the straightening of the arc; the amount of outward motion, or motion away from the centre, is therefore gradually increased as the temperature falls, and with it the inertia, and the chronometer loses. Heat has the opposite effect on the arc; it curves more inward, the diagonal dotted line is shortened, and the motion is gradually decreased. The tension of the spring meanwhile decreases in a greater ratio, and the chronometer again loses.

Many contrivances have been proposed and tried for the purpose of obviating this defect; but it will be evident, that any auxiliary compensation which only comes into operation at certain times must be defective, inasmuch as although we have spoken of extreme temperatures, the same effect will take place in degree in any range of temperature, however small. Continuity of action is therefore essential to the excellence of any contrivance for attaining uniformity of rate.

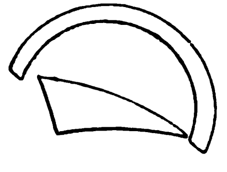
For some years subsequently to the trials of Arnold's and Earnshaw's chronometers, premiums were offered by Government for those timekeepers which should after a lengthened trial at the Greenwich Observatory have been found to perform within certain limits, and those makers who effected any improvement, attained any excellence, or who wished to possess the honour of selling their timekeepers to the Government, were allowed to send their instruments to the Observatory, where their performances were tested, and those which came up to a certain standard were bought at the market price. This arrangement still continues, and by its means the Government is enabled to secure the best chronometers that are offered. The trial rates of all the chronometers so sent in are published yearly, and widely circulated among those likely to take an interest in them. It would seem from these returns, that a very small proportion of the timekeepers so tested have the ordinary construction of compensation balance, although the few thus tested have stood above many with auxiliary contrivances. It is somewhat curious, that many of the expedients adopted bear a strong likeness to older inventions. One of the most successful plans has been the adoption of a secondary compensation, composed of small glass tubes containing mercury so shaped and placed as to give the required effect. These mercurial tubes were first used by Le Roy. Another modification has been introduced by Mr. Hartnup, and has been already described in this Journal. Judging, however, from the practice of chronometer makers, it does not seem that any especial contrivance has yet received favour, and from the way in which the several chronometers of each maker stand apart in the list of rates, and the way in which each construction varies its position in that list in different years, it does not seem as though any *unpublished* construction has yet attained the perfection to be desired.

We must now return to notice briefly the introduction of those leading principles of construction which have been adopted in pocket watches.

The earliest escapement applied to a watch was the *vertical*, which it is unnecessary to again describe, as it has already come before us when considering the details of De Wick's clock.

We owe the first important improvement to Graham, who applied his dead beat escapement for clocks to watches, by reducing the radius of the pallet planes of rest, so that they included one tooth only of the escape wheel. At the same time he prolonged these planes, so as to make the form of the section of the pallets a semi-cylinder (see *fig.* 47); hence the term *cylinder* is employed, instead of pallets.

Fig. 47.

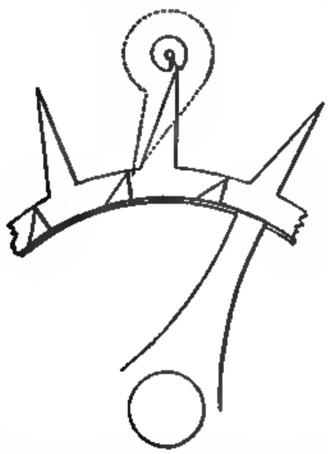


This hollow cylinder was cut away just below the place of action, so as just to leave sufficient material to connect the lower with the upper portion, and to allow the pallets to pass over the plane of the wheel in the course of their vibration. The teeth were wedge-shaped

and were elevated above that plane. Plugs and pivots were inserted into the upper and lower ends of the cylinder, the upper plug bearing the balance. This escapement is chiefly known as the *horizontal* escapement, from the escape wheel revolving in a horizontal plane, instead of one vertical to the frames. It possesses the same advantages as the clock dead escapement does; it does not recoil, and it maintains a very uniform rate of performance. Its defects are, that it requires a considerable supply of oil, which alters in fluidity, and with it the rate of performance. It is also delicate and easily broken.

The *duplex* escapement originated with Dr. Hooke, and was afterwards modified by various mechanists until some eighty years ago, when it received its present form. (See *fig.* 48.) Originally it had two separate

Fig. 48



wheels; these were afterwards placed on the same arbor, one being much larger than the other; the larger was called the wheel of *repose*, and the smaller the wheel of *impulse*. In its present shape the wheel consists of two sets of teeth, the longest resting against a small roller placed on the staff and escaping through a vertical notch cut in it. At the instant of the escape one of the upright teeth drops upon the steel pallet and gives the impulse.

This escapement is found to perform with very great accuracy when well made. Its defects are the slight friction on the surface of the roller, and also a slight recoil as the tooth drops into the notch on the return vibration. Some object to it because it is said to be easily deranged, but opinions differ as to its liability to injury from external violence.

The *lever* escapement was introduced by Mudge pretty nearly in its present form. It was first contrived in principle by the Abbé Hautfeuille in 1722. His form was the rack lever, which some years afterwards was patented at Liverpool, and consisted of the ordinary anchor clock escapement with a toothed lever added, which acted into a pinion on the axis of the balance. As now constructed it resembles the dead-beat clock escapement with an addition of a forked lever which takes into a pin placed on a roller on the axis of the balance. (See *fig.* 49.) When

Fig. 49.

properly constructed, the lever escapement is a good and serviceable one. Its great defect is the introduction of an extra element into the escapement, which involves increased friction; thickening of the oil on the planes of the pallet also materially affects the amount of impulsive force, and with it the time of vibration, unless a perfectly isochronal spring is used, which is seldom the case. Acceleration of vibration is sometimes caused by external motion causing the roller pin to strike the fork, or, as it is termed, "strike the bankings." This has been partially remedied in a modification by Mr. Cole, which has already been described in this journal under the name of the "Resilient Lever Escapement."

We have now completed our sketch of the history of the Science of Horology. A mere outline, as it professes to be, cannot be expected to add much to the knowledge of old students, but simply is intended to put in a condensed form the leading facts of the science, for the use of those who may desire to possess an epitome of the subject.

On taking leave of our readers we may perhaps be permitted to express the opinion, that much yet remains to be done in reducing the construction of timekeepers to a science of fixed principles and known laws. How

few there are, even amongst our most skilful workmen, who can give a good scientific reason for the course they follow or the construction they adopt! We simply follow a plan, because we find it answer our purpose, or because our masters taught it to us, without an intelligent knowledge of the reason why. How is this to be remedied? How are we to be able to give a reason for all our processes, and a law and principle for all our constructions? We answer, simply by educating ourselves in the study of principles, and making a knowledge of the laws of science the basis and foundation on which all our practice is built. Until we do this we must be content with the uncertainty which ever attends a mere rule of thumb procedure, and bear with the consequent disappointment and loss which will be the inevitable result of energy without knowledge.

W. HISLOP.

LE ROY'S PRIZE CHRONOMETER,

WITH A MEMOIR ON THE BEST METHOD OF MEASURING TIME AT SEA.

(*Continued from page* 57.)

To find out the degree of freedom preserved to the regulator by my escapement, I made an experiment similar to that which I made with Graham's escapement. I took away from my balance the pallet *p*, by which the balance wheel restores the motion, leaving only the detent. Having then removed this regulator from the point of rest about 90°, it vibrated seven minutes nearly; at the end of this time it would even yet describe in its vibrations a sensible arc, although not sufficiently great to disengage the detent. I conclude from this, that the influence of friction is almost nothing in my regulator; for the detent, although very slight, has nevertheless a small mass, and in the preceding experiment the regulator could not move it in each vibration without employing a considerable part of the lost force; whence we may legitimately infer, that what is destroyed by friction is almost nothing. Now the obstacle arising from my detent must be reputed of no value, consisting in a mass always the same, whilst the friction varies continually.

I made the same trial with a seconds pendulum having an anchor escapement. The whole motion of the pendulum ceased in about thirty minutes, whence I believe I can conclude, considering what has been said of the resistance of the detent, and of the motion which remains to the balance after seven minutes, that this balance in the new watch has almost as much regulating power as this pendulum. I have said that my pallet was situated near the circumference of the balance. I placed it thus in order that it might be drawn by a point in its circumference of percussion, which point is where the wheel in its action makes no effort on the pivots, and where the balance only receives the circular motion.*

Moreover, although the escapement of the new watch, and that which M. Le Roy presented to the Academy in 1748, are founded on the same principle, they differ nevertheless essentially.

In the first, the effect of the detent operates by means of a small spring, which brings it back into the teeth of the wheel; in the latter there is nothing of that kind, as we have seen. Various trials have proved to me the inconvenience of the spring escapements. These springs are either strong or weak; in the first case it is to be feared that the detent would be disengaged by shocks; in the second, you give to the regulator a considerable obstacle to overcome in each vibration, which obstacle being the same for the smallest as it is for the largest arcs, must be disadvantageous. Besides, if this detent, that is moved by so feeble a spring, meets with ever so slight a difficulty, or if this spring loses in strength, it does not enter sufficiently quick into the teeth of the balance wheel, and then several teeth escape. Lastly, after many attempts of this kind, I was only completely satisfied with that of the new marine watch.

ARTICLE VI.

Of the Compensation for the effects of Heat and Cold. —Of the necessity of preserving to the Spiral Spring an invariable length.—Means by which, without changing this length, we regulate the New Watch in almost the smallest quantity.—Description of the New Compensation, &c.

The first thing I thought necessary to clear up before I attempted to compensate the

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* It is extraordinary that M. Le Roy no where mentions his having applied jewels either to the pivot holes or to the balance of his watch. Sully (p. 248, *Regle Artif. du Temps*) says, that in 1704 Sir Isaac Newton showed him a watch that was put into his hands to try by Messrs. Facio and De Baufre, the pallets of whose balance were formed of a diamond; and expressly mentions that the art of piercing rubies was invented by this M. Facio, of Geneva, about the year 1700. The utility of their application must therefore have been fully known to watchmakers at the time Le Roy wrote this paper, and it is extraordinary that he did not make use of this additional advantage.

effects of the different degrees of heat and cold in my machine, was the proportion that its gain or loss followed by these different degrees. I feared much that this progression was not proportional to that of the degrees marked by the thermometer; that, for example, the watch having lost three seconds for six degrees of ascent in the thermometer, it would not lose six for twelve degrees of this same instrument, but either a greater or less quantity. Various reiterated experiments happily proved to me that my fears were unfounded; that when the regulator was free, as it is in my machine, the progression of gain or loss absolutely follows that of the thermometer—that is to say, that the watch losing three seconds when the thermometer from 0° passes to 6°; it will lose six at 12°, nine at 18°, and so on. If in our researches Nature often contradicts our views, we may say that she is sometimes more favourable than we had reason to hope: of this the precision to which clock work has arrived furnishes undoubted proofs.

All this shows the indispensable necessity of having a perfectly free regulator, without which the effect of heat on the machine depending more or less on the fluidity of the oil, which is very variable in different degrees of heat and cold, and the alterations of this fluidity produced by time and by the wear of the parts, &c., the progression remarked above no longer takes place, and has not even any thing certain. This is a just objection made by M. Basser* against Mr. Harrison, among a number of others which are not so.

After being well assured of the fact I have just described, it appeared necessary to examine a second, not less important to clear up, and to know whether metals would follow the same progression as fluids in their extension or contraction by heat and cold; which required very nice experiments. To make them with some success, I nailed, in a cabinet against a thick stone wall, at four feet distance from each other in a vertical line, two potences of copper, the upper one of which carried an index of thin hard steel about four feet in length, which descended almost vertically. I then took three rods—one of copper, one of iron, and one of steel—of nearly equal size, and four feet in length. I had made to each of these rods, as well as to a tube of glass of exactly the same length to serve as a standard, a sheath, made sufficiently thick, of cloth. These rods and this tube were adjusted firmly without being able to turn by their lower extremity, and by a pivot adapted to their upper extremity they caused the index to move, whose path was marked on a limb.

All being equal in the arrangement of the three rods and the tube, I began my experiments; and I presently saw that, to have any thing exact on this subject, it was necessary that the rods should remain a long time exposed to the degree of heat and cold in which we could make these experiments; particularly when, from a considerable degree of heat, as 20 or 30 degrees,* for example, I wished to remove my rods to a degree of cold approaching that of ice. The reason is known: by the experiments of Boerhaave, and those of Newton, bodies attract heat in proportion to their specific gravities. Now, when you would remove a body whose degree of cold corresponds to 0° of the thermometer, for example, to the term 30 degrees of this same instrument, by placing it in an air that is of this degree, it is clear that by its attraction it will presently have acquired the quantity of caloric that will give it the heat of 30°. But it will not be the same if you then remove the body to an air where the thermometer is 0°†, to make it acquire this degree of cold; for then, its attraction being much stronger than that which the ambient air opposes to the quitting of the particles of caloric, it cools with so much the more difficulty. I have found, indeed, that after having heated our rods and replaced them again in the temperature 0° whence they had been taken, it required some time—almost twelve hours—to reduce them to the length they were before, that is to say, for the overplus of caloric totally to abandon the interior.

After having found this effect, and paid the greatest attention in my experiments, I happened at last to find in their results the exactness which I had vainly sought for before; and I found that the glass and metals in their contractions and expansions followed precisely (as well as the augmentations and losses of elasticity of springs) the proportion of the degrees described by the spirit of wine thermometer. These methods of proving the various contractions and dilatations of metals appear to me very exact: for, first, the cabinet where the instrument was placed being defended from the external air, no considerable change could happen to the wall (which was hung with tapestry, and to which our potences were fixed) between one experiment and the other; 2ndly, when it does happen—and, in

* See the *Gazette du Commerce*.

* Of Reaumur's thermometer, equal to from 77° to 99½° of Fahrenheit's.

† 32° of Fahrenheit's.

effect, it is sometimes seen very evidently, that the wall of which I have spoken is dilated by heat, as much as the steel very nearly—then, I say, this effect is announced to us by the spirit of wine thermometer on the one part, and by the tube of glass on the other, which was very little dilatable ; and which tube may, besides, be kept in the same temperature. The sheaths with which our rods were covered enabled them to be removed from one place to another—that is to say, from a stove or from a cool place in the cabinet of trial—and to adjust them on the instrument before they had undergone any alterations in their dimensions and their degree of cold or heat, which would not appear practicable otherwise. Being well assured of these facts, I turned my attention to compensating the effects of heat and cold in my machine.

The first idea that occurred to me, as to many others, was, to apply to the regulating spring a metallic thermometer which would shorten or lengthen it by different temperatures, as has been practised in the seconds pendulum. I presently found the insufficiency of this method. Having in my machine two regulating springs of about 18 inches each, to produce the desired effect the shortening or lengthening would be proportional to this length. By the computation which I made, four lines passed over in the compensation pyrometer would barely have sufficed. Now, three feet of copper combined with three feet of steel hardly gives a sixth of a line of difference in their lengthening for 30 degrees of ascent in the liquor of the thermometer. We see, therefore, that I had not the power of obtaining an exact compensation unless by multiplying the effect by very large levers and a great number of metallic bars ; but all this brings in a play of the parts, and a want of solidity in the pieces of the regulator, absolutely incompatible with the desired exactness.

A second consideration determined me against making use of these expedients in my machine, and in general all those that alter the length of the regulating spring ; which is, as I have explained, that the isochronism of the vibrations absolutely depends on a certain length of the spiral springs. Now, every method which renders this length variable, not even excepting that of Mr. Harrison, although very ingenious, is on this account inadmissible.

Here, I am sensible, an objection may be made to me, which I shall make myself. As a spring loses its elastic force by heat, it may be suspected that the place in its length where all the vibrations are isochronous cannot be the same in different degrees of heat and cold. The following are the experiments which dispelled my doubts on this subject :—After having found, by experiment in a temperate place, the length of a spring where all its vibrations, long and short, were isochronous, I removed the machine to a cold five degrees below freezing ;* the watch experienced an advance proportional to the cold (for the sake of greater simplicity I had not applied any thermometer to it) ; then I made it go six hours the great spring being almost down, and during six hours the machine being wound to the top, which produced a difference of one half in the extent of the arcs. I found, then, that the regulating spring had preserved all the isochronism of its vibrations, the machine having advanced precisely the same quantity in the first six hours as in the six last. Not contented with this trial, I removed the machine into a stove where the thermometer constantly stood at about 35 or 40 degrees,† it then retarded proportionally to this degree of heat. I repeated the above trial, which again gave me the same result ; whence it follows, that the different degrees of heat do not sensibly change the laws of isochronism in springs.

I concluded from this experiment, that, whatever expedient we may use to render the vibrations of the balance isochronous, the inconvenience remarked above in the compensations which are made by the shortening or lengthening of the spiral spring does nevertheless take place. For, let it be by means of a compensation curb formed at the parts of the escapement or applied to the spiral spring, &c., that the isochronism is produced, or by other similar methods, it will be perceived that these curbs &c. are always according to the relations which exist in the times of vibrations of different extent of this spring, supposed to be free ; and these relations can never change without the conditions of these curbs varying at the same time. Thus all the reasons which have induced me to render the length of the spiral invariable must also apply, in whatever construction it may be, where we aspire to give the greatest degree of accuracy to a watch. It follows again, from what precedes, that nothing can be more opposite to the regularity of a marine watch than to regulate it, as in common watches, by shortening or lengthening the spiral ; therefore, for my own part, I took good care not to make use of it in my watch. For this purpose I have placed two screws, G Z, G Z (Plate III. *fig.* 6.), perfectly equal, at the bottom of the balance arbor ; so that

* About 20¾° of Fahrenheit.

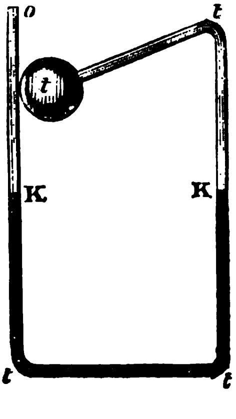
† From 110¾° to 122° of Fahrenheit.

we may, by turning them with the hand, make them approach or recede equally from this arbor. These screws by their mass, which may be diminished at pleasure according to the exigency of the case, and which we may make to describe a large space, permit us to regulate the machine to the greatest nicety. If the effects of heat and cold were less durable, the inconvenience I have just explained might be neglected; but as the machine is in a state of trial during more than six months together, it is clear that as the vibrations of different extent of the regulator have not then the requisite isochronism, the causes which may make the magnitude of these vibrations vary would alter the regularity of the clock considerably. Convinced of the principle I have just established, to compensate the effects of different temperatures in my machine, I took a method altogether new. I adapted to the balance several small bars of copper and steel, disposed in such a manner that, by their lengthening or shortening in heat and cold, they make to approach or recede from its centre two considerable parts of its mass, each placed at the extremity of a lever and diametrically opposite.

By the computation which I had made, it sufficed that the total mass of the balance should approach or recede from the centre by about the thirteenth part of a line, to compensate a variation in heat which would produce one of 15 seconds per hour in the rate of the watch.

One inconvenience of the preceding method made me abandon this presently; the play of the levers and the small solidity of the balance produced errors greater than those which I wished to compensate. This made me have recourse to a third method, which completely succeeded. It consists in applying to the balance two small thermometers, *ttttt* &c. (Plate III., *fig.* 6), each made of a tube of bent glass, open at *o* (*fig.* 7).

Plate III. Fig. 7.



These thermometers, composed of mercury and spirit of wine, would each form an exact parallelogram if the upper side which carries the ball, on which is contained the spirit of wine as well as in this side, were not a little inclined. Both these thermometers are firmly adjusted and placed on opposite sides of the arbor of the regulator, so that the axis of their tubes and that of the balance are in the same plane that cuts the balls through the middle. It is easy to conceive how this construction produces the required compensation. The thermometers making part of the regulator, when the spirit of wine by its dilatation pushes a part of the mercury contained in the outer branch *t t* (*fig.* 7) towards that, *t o*, which is near the axis of motion, a portion of the mercury forming part of the mass of the regulator passes then from its circumference towards its centre. At temperate, for example, the mercury occupies the parts *t k k t* of the tube, whilst in extreme cold, when Reaumur's thermometer is at 15 degrees below freezing,* the branch *t o* is empty, and that corresponding, *t t*, is full of mercury. Now, as the mass of a balance resists in the ratio of the square of its distance from the centre, there arises evidently from this a compensation; the retardation arising from losses of elasticity in springs, and from the dilatation of the balance by great heat, being compensated by the loss of mass in the circumference of the regulator, and *vice versa* in the passage to cold. This effect is so much the more certain, as there is no play to fear here: besides, the dilatation of spirits of wine by heat, and its condensation by cold, are constant effects (as we have found by the thermometers) of this liquor, which at the end of thirty years had lost nothing of their exactness. The following is the computation of these thermometers, to which I have given the form we see them of, in order that the balls might be turned towards the centre of the balance, and also to diminish the resistance that the air gives to the motion if it was near the circumference.

(*To be continued.*)

CURIOUS *MEMENTO MORI* WATCH.

This curious and interesting relic is now in the possession of Sir Thomas Dick Lauder, of Grange and Fountain Hall, Baronet, who inherited it through the Seaton family, from which he is descended; it having been given

* Or $1\frac{3}{4}$ below zero of Fahrenheit's.

by Queen Mary to Mary Seaton, of the house of Wintoun, one of the four celebrated Mary's who were maids of honour to her Majesty.

The watch is of silver, in the form of a skull. On the forehead of the skull is the figure of Death with his scythe and sand glass; he stands between a palace on the one hand and a cottage on the other, with his toes applied equally to the door of each; and around this is a legend, in Latin, from Horace, signifying—

> "Pale Death visits with impartial foot the cottages of the poor and the palaces of the rich."

On the opposite or posterior part of the skull is a representation of Time devouring all things, with an inscription from Horace, which may be rendered thus:—

> "Time, and thou too, envious Old Age, devour all things."

He also has a scythe; and near him is a serpent with its tail in its mouth, being an emblem of Eternity.

The upper part of the skull is divided into two compartments:—On one is represented our First Parents in the garden of Eden, attended by some of the animals, with the motto, in Latin—

> "By sin they brought eternal misery and destruction on their posterity."

The opposite compartment is filled with the subject of the salvation of lost man by the crucifixion of our Saviour, who is represented as suffering between two thieves, whilst the Mary's are in adoration below; the motto to this is—

> "Thus was Justice satisfied, Death overcome, and salvation obtained."

Running below these compartments on both sides there is an open work, of about an inch in width, to permit the sound to come out freely when the watch strikes. This is formed of emblems belonging to the crucifixion,—scourges of various kinds, swords, the flagon and cup of the Eucharist, the cross, pincers, lantern used in the garden, spears of different kinds—one with the sponge on its point, thongs, ladder, the coat without seam, and the dice that were thrown for it, the hammer and nails, and the crown of thorns. Under all these is the motto—

> "The way to glory is the 'ladder' to Heaven."

The watch is opened by reversing the skull, and placing the upper part of it in the hollow of the hand, and then lifting the under jaw, which rises on a hinge. Inside, on the plate, is a representation of the Holy Family in the stable, with the infant Jesus laid in the manger, and angels ministering to him; in the upper part an angel is seen descending with a scroll on which is written—

> "Glory to God in the highest; on earth peace, and goodwill to all."

In the distance are the shepherds with their flocks.

The works of the watch occupy the position of the brain in the skull itself, the dial plate being on a flat where the roof of the mouth and parts behind it under the base of the brain are to be found in the human subject. The dial is of silver, and fixed within a golden circle richly carved in a scroll pattern; the hours are marked in large Roman letters, and within them is the figure of Saturn devouring his children.

On examining the works, they are found to be wonderfully entire. There is no date, but the maker's name and the place of manufacture, "*Moyse, Blois,*" are distinctly engraven. Blois is the place where it is believed that watches were first made; and this suggests the probability of the opinion, that the watch was expressly ordered by Queen Mary at Blois when she went there with her husband the Dauphin.

The watch appears to have been originally constructed with catgut instead of the chain which it now has, which must have been a more modern addition. It is now in perfect order and performs wonderfully well, though it requires to be wound up within 26 hours to keep it going with tolerable accuracy. A large silver bell, of very musical sound, fills the entire hollow of the skull, and receives the works within it when shut: a small hammer, set in motion by a separate escapement, strikes the hours on it.

This very curious relic must have been intended to occupy a stationary place on a *prie-dieu* or small altar in a private oratory, for its weight is too great to have admitted of its being carried in any way attached to the person.—(*Abridged from Smith's Historical and Literary Curiosities:* Bohn, London, 1845.)

THE IMPERIAL STANDARD YARD.

To the Editor of the Horological Journal.

Sir,—The pendulum referred to in Mr. Jones's enquiry in your last number, is a *simple* pendulum oscillating in an arc *infinitely small.* But as such a pendulum can only exist in theory, we must have recourse to the plan adopted in 1817 by Captain Kater, who was deputed by the Royal Society to ascertain the length of a pendulum vibrating

seconds in the latitude of London, in consequence of an address of the House of Commons to the Prince Regent on the subject.

After several ineffectual attempts, Captain Kater availed himself of a principle long known to mathematicians, but never before made practically useful, viz., that the centres of suspension and oscillation are reciprocal; or, in other words, that if a body be suspended by its centre of oscillation, its former point of suspension becomes the centre of oscillation, and the vibrations in both positions will be performed in equal times.

He therefore made a pendulum with knife edges at both these points, and allowing it to oscillate freely, by an ingenious process of observation by coincidences (a description of which would occupy too much space in your columns), he ascertained the number of its vibrations in twenty-four hours.

The length between the knife edges was now found by micrometer measurement in comparison with the standard scale in possession of the House of Commons, and correction was made for the difference between the circular and cycloidal arcs, so as to reduce it to an arc infinitely small.

As pertinent to Mr. Jones's question, I may add, that the error arising from the greater length of vibration in a circular arc is nearly as the square of the arc; and in this instance the mean of the arcs of vibration was taken, and its square multiplied by 1·635 (the difference between the number of vibrations made by the pendulum in twenty-four hours in a cycloid and in an arc of one degree), and the result added to the number of vibrations before computed. Corrections were also made for the difference between the height of the barometer and a vacuum,—for the height of the thermometer and 62°,—and for the height of Portland-place, where the experiments were conducted, and the level of the sea.

Having now obtained a pendulum of a certain length oscillating in certain times, the true length of a pendulum vibrating seconds was readily deduced.

Therefore, if the standard measure should at any time be destroyed, we have the means of restoring it.

I am, Sir, your obedient servant,

74, Cornhill. R. WEBSTER.

SELF-WINDING CLOCK. — After years of mechanical labour and many mathematical tests, Mr. James White, of Wickham Market, has completed, and has now in constant operation a self-winding clock, which determines the time with unfailing accuracy, continuing a constant motion by itself, never requiring to be wound up, and which will perpetuate its movements as long as its component parts exist.—*Norwich Mercury.*

EQUATION OF TIME TABLE

For JANUARY, 1860.

Day of the Week	Day of Mnth	At APPARENT NOON — Equation of Time to be *added* to Apparent Time.	Difference for One Hour.	At MEAN NOON — Equation of Time to be *subtracted* from Mean Time.
		m. s.	s.	m. s.
Sun. ..	1	3 37·06	1.182	3 36·99
Mon...	2	4 5·42	1·167	4 5·34
Tues..	3	4 33·41	1·150	4 33·32
Wed ..	4	5 1·01	1·133	5 0·92
Thurs.	5	5 28·20	1·115	5 28·09
Fri. ..	6	5 54·95	1·096	5 54·84
Sat. ..	7	6 21·22	1·075	6 21·11
Sun...	8	6 47·01	1·053	6 46·89
Mon...	9	7 12·27	1·031	7 12·15
Tues..	10	7 37·01	1·008	7 36·88
Wed ..	11	8 1·19	0·984	8 1·06
Thurs.	12	8 24·81	0·959	8 24·68
Fri. ..	13	8 47·83	0·933	8 47·69
Sat. ..	14	9 10·22	0·907	9 10·08
Sun...	15	9 31·99	0·880	9 31·85
Mon...	16	9 53·11	0·852	9 52·97
Tues..	17	10 13·57	0·823	10 13·43
Wed ..	18	10 33·33	0·794	10 33·19
Thurs·	19	10 52·38	0·764	10 52·24
Fri. ..	20	11 10·71	0·733	11 10·57
Sat. ..	21	11 28·30	0·702	11 28·17
Sun...	22	11 45·14	0·670	11 45·01
Mon...	23	12 1·21	0·637	12 1·08
Tues ..	24	12 16·49	0·604	12 16·37
Wed ..	25	12 30·98	0·570	12 30·86
Thurs.	26	12 44·65	0·536	12 44·54
Fri....	27	12 57·51	0·501	12 57·40
Sat. ..	28	13 9·53	0·467	13 9·43
Sun. ..	29	13 20·72	0·432	13 20·62
Mon...	30	13 31·08	0·397	13 30·99
Tues ..	31	13 40·59	0·361	13 40·51

TO CORRESPONDENTS, &c.

C——Y.—Contrary to our usual custom of not returning manuscripts or correspondence, we will, in this instance, from courtesy, forward to C——y a correct copy of his letter. Any communication on the sizes of wheels and pinions, as the result of his experience, shall be duly considered.

*** Anonymous Communications cannot be attended to.

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THE BRITISH HOROLOGICAL INSTITUTE.

DISCUSSION MEETINGS.

On Thursday, 1st December, 1859, the *fourth* discussion took place at the Institute; the question being "*What is the reason the Swiss possess a larger market for their manufacture than ourselves? and has the Education of the workmen anything to do with it?*" Mr. J. F. COLE being called to the Chair, introduced the opener,

MR. JONES, who said,—We have heard much of late on the subject "*How to Make a Watch,*"—not always, perhaps, treated by those most competent to counsel us: I have to-night to draw your attention to the question, *How to Sell a Watch.* The primary purpose of this Society is to explore the principles of Nature applicable to our art, and, in the common pursuit of truth forgetting the rivalries of interest, to enjoy the pleasure of the discovery of Nature's laws in their hidden retreats; that each carrying away additional mental riches from the treasury of Science, which is inexhaustible, our evenings may be the luxury of our intellectual lives. I lament that my duty to-night does not favour this abstract enjoyment. I have to talk of the war of interests, where passions are engaged, and where the utterance of opinion is too liable to evoke towards the speaker praise or blame rather according to interest than right. Truly the question I have in hand is great and important; it might well employ the notice, as it would exhaust the faculties, of the ablest of our statesmen, since the principles involved are those that lie at the root of England's power,—the relations of labour and capital, the influence of the cost of living on wages, and the measurement of the commercial value of skill and science. The fact of the matter is, that we are undergoing the wasting process of an invasion as certainly destructive as an armed power, and we must combine—the master, the workman, the capitalist, the distributor — in making common cause against the enemy.

The question is, Why has Switzerland gained upon us in the manufacture of watches? It is well to see, as far as we can, what are the respective productions of the two countries. Mr. Bennett, who has given some attention to the question, alleges that the production of Switzerland amounts to a million and a half of watches annually. I do not find this to be correct, according to the best examination I can give to it. I have looked through the returns of the Governments of France, England, and the United States, the three largest consumers in the world; I have also collected the returns from other European and foreign Governments, and I find that about 355,884 watches was the production of Switzerland in 1858, or, allowing for errors, say 400,000. There is some difficulty in this conclusion from the different methods in which different Governments keep their accounts; some only reckoning value, others numbers. Switzerland herself only keeps an account, under one head, of the number of hundredweights of clocks and watches which leave her frontiers. Being, however, an inland state, her goods must pass through her frontier states; and the country which undoubtedly forms the chief vent for her commodities is France. The French returns give this statement:—

France imported in 1858—

Watches, Gold and Silver,	
From Switzerland	279,942
From other countries..................	4,907
	284,879

of which the official value was £570,000; the actual value declared for payment of duty £330,000.

The numbers sent to other countries from Switzerland I thus estimate:—

To France (as above)......................	284,879
Russia	34,000
Austria	15,000
Norway	7,379
Sardinia	10,744
Belgium	4,892
	346,894

Allow for smuggling, &c., and say 500,000.

I have not introduced England, for the whole of her watches she receives through France. The United States also receive their supply through France; the Indies and Brazils the same. The total then may fairly, I believe, stand as I have given it.

Assuming that one in three of the Watches exported are Gold, and fixing 30*s.* as the value of the Silver, and £4 as the value of the Gold, I find the value of Swiss exports for 1858 was—

Of Silver Watches	£500,000
Gold......	666,800
	£1,166,800

The returns of the Goldsmiths' Hall of England enable us to reach our production more correctly. In 1858 our numbers were—

In London, Silver Watches	83,614	...Gold	24,870
Chester	13,648	„	8,200
Coventry	16,000		
	113,262		33,070

Total number of Watches................146,332

Taking the value of the English Silver Watches at £3, and of the Gold at £10, the total value would be—

Of Silver Watches	£339,786
Of Gold ditto	330,700
Total value	£670,486

Showing that, as compared with the Swiss production, our number is one-third, and our value one-half.

That this is not an accurate return I know since I frequently send watches abroad by th dozen, and give no other report of them than th the case contains watches; from which therefo the Government cannot obtain any correct info mation. I believe, however, that France is mo exact. In taking account also of our productio the large number made without cases for Ameri must also be allowed for.

The following Tables are interesting:—

France Exported in 1858—

		Official Value.	Actual Valu
To England	...fr. 3,142,235 or	£124,800	£190,0(
Belgium	 380,389	15,200	24,0(
Portugal	 72,787	3,600	5,5(
Two Sicilies	... 45,190	1,800	2,7(
Spain	 208,117	8,320	14,0(
Switzerland	... 156,061	6,240	9,5(
Turkey	 190,187	7,600	11,4(
Egypt	 30,275	1,200	1,9(
United States	.. 717,650	34,800	52,0(
Brazil	 62,050	2,400	3,6(
Algeria	 46,680	1,800	2,7(
Other Countries	168,413	7,000	10,0(
	Fr. 5,220,034		

Of which were sent in French ships 509,924 fr ; foreign ships, 4,115,307 fr. ; by hand, 594,803 f

The official value was 5,220,034 fr. or £208,00 actual value 8,220,035 fr. or £328,000.

Comparative Value of Exports from France Home and Foreign Work, 1857.

Silver Watches	.........fr. 2,831,513 or	£113,2
Gold ditto	 4,877,565	194,8
		£308,0

Of which the Home Manufacture was—

In Silver	..........................fr. 10,311 or	£4
In Gold	 62,210	2,4

Taking each silver watch at 30*s.* and each g watch at £4, would give—

Silver Watches	75,0
Gold ditto	48,0
Total number of Watches	123,0

Exported from Great Britain in 1854—

	Home Manufacture.	Forei
To France	70 watches	5,0
Egypt	162	4,2
China	8	3
United States	23,307	1,8
Brazil	398	1
Buyenos Ayres	148	
Channel Islands	1,528	
British Possessions in South Africa	336	8
Mauritius	62	2
British East Indies	1,221	2
Australia	7,908	26,9
British North America	406	4
	36,872	41,(

Value of Home manufacture	£146,700
Foreign	73,013
Total value	£219,713

Exported from Great Britain in 1857—

	Home manufacture.	Foreign
To Hanse Towns	2,075 watches	304
France	188	517
Spain	91	3
Turkey	2,110	704
Egypt	688	3,006
Cuba	290	—
St. Thomas	414	24
United States	14,141	400
Granada	97	17
Brazil	2,121	358
Chili	117	—
Channel Islands	1,407	1,000
South Africa	556	559
British East Indies	823	236
Australia	3,082	6,722
British North America	248	770
Other Countries	1,158	1,185
	29,854	15,885

Value of Home manufacture	£150,000
Foreign	25,585
Total value	£175,585

Great Britain imported—

	In 1854	1855	1856	1857	1858
Watches	110,052	94,628	90,000	88,621	99,329

1859 (9 months.)
75,160

Of which she retained for home consumption:—

In 1854	1855	1856	1857	1858	1859
79,209	90,670	84,881	79,991	88,710	71,525

United States imported—

	In 1856	1857	1858
	Dollars-worth.	Dollars.	Dollars.
From England	2,186,644	2,463,593	1,043,565
Or	£437,328	£492,718	£208,713
	Dollars-worth.	Dollars.	Dollars.
From France..	1,418,013	1,155,654	953,134
Or	£281,602	£231,130	£190,626

France imported in 1858—

Watches in Gold and Silver:

From Switzerland	279,972
From other Countries	4,907
	[illegible]

Of which there were brought in French ships 34,100 fr.; in foreign ships, 47,700 fr.; by hand, 14,162,150 francs.

The official value of the whole was 14,243,950 fr. or £569,756; the actual value, 8,261,491 fr. or £338,456.

Sweden imported—
(Value in Rix dollars at 1*s.* 8*d.* each)

In 1848	1849	1850	1851	1852
35,256	38,762	48,358	49,473	46,578
£2938	3230	4029	4122	3881
1853	1854	1855	1856	1857
36,883	94,061	115,147	236,358	164,679
£3073	7921	9595	19,613	12,753

Russia imported in 1856—
33,969 watches; value 116,812 silver roubles (of six roubles to the £ sterling) or £18,468.

Austria imports—
As nearly as I can ascertain, about £20,000 worth of Swiss watches.

Spain imported—
Of Clocks and Watches, in reals of 100 to the £ sterling.

	In 1851	1852	1853
Reals	3,745,563	3,794,701	3,828,651
	£37,455	£37,947	£38,286
	1854	1855	1856
	3,450,398	4,427,807	5,340,136
	£34,503	£44,278	£53,401

Norway imports—

Gold Watches	594
Silver	5501
Metal	1284
	7379

Sardinia imported—

	In 1852	1853	1854
Watches ...	10,744	10,283	10,339
	1855	1856	
	11,513	14,089	

Belgium imported—

	In 1854	In 1855
Silver Watches......	13,310	13,788
Value.........	530,400 fr.	551,520 fr.
	£21,200	£22,000
Gold Watches	8,135	7,441
Value.........	976,200 fr.	892 920 fr.
	£38,000	£36,000

Of which come from Prussia—
Gold 824, value 9880 fr. or £392
Silver 1533, value 61,320 fr. or £2452
From France:—
Gold 5237, value 628,400 fr. or £28,000;
Silver 8713, value 348,000 fr. or £13,600.
From Switzerland:—
Gold 1375, value 165,000 fr. or £6600
Silver 3517, value 140,680 fr. or £5624

The nearest estimate I can obtain as to the numbers of the population of Switzerland is as follows:—The total population of Switzerland is 2,392,740.

In 1834, in the Canton of Neufchatel the population was	56,073
In 1848 the Canton of Neufchatel had a population of	68,500
In 1856 the population of Neufchatel had increased to	80,709

Dr. Bowring gives 120,000 watches as the annual product of this canton in 1834. Now double this for increased numbers and increased facilities, and it will give 240,000 watches as the product now.

Murray gives 3000 workmen as the number in Geneva, and the annual product of Geneva to be 80,000, and we have a total of watches... 320,000
Give other Cantons .... „ 100,000
And this brings somewhat similar results with the conclusion drawn from exports as the annual product, viz. 420,000

The numbers of English workmen is thus from the census of 1851:—

In London, of all ages	4847
In Warwickshire, do.	2219
In Coventry, over 20 years of age	1104
———Apprentices (probable number)	700
In Liverpool, over 20 years of age	1158
At Prescot, movement makers	710
Total engaged in the manufacture	10,738

Comprehending those engaged in jobbing and selling as well as manufacturing there were 19,159 of both sexes in the watch trade; viz.

Of Males, under 20 years of age	3,440
„ above 20	15,338
Of Females, under 20 years of age	115
„ above 20	266
	19,159

Are the Swiss encroaching upon you? I think the returns I have here show it. In 1856 they imported into England 90,000 watches; in 1858, 99,329. How is this? First, they defraud us by imitating our names. Then their more elegant work satisfies a class to whom form and beauty are the chief requisites, irrespectively of prices. These, however, are but few; it is the bulk of society we live by. The main fact is, that the Swiss produce a cheaper article. The English lever is a better manufacture than the Swiss cylinder; but the time-keeping qualities, irrespective of durability, are sufficient with the moderately good Swiss work. In London trade recognizes more small independent masters than the Swiss trade, the profits of the several trades swelling the aggregate. The manufacturers require a larger profit than satisfies the Swiss manufacturer. I remember a Swiss manufacturer, with whom I am familiar, telling me that £100 per annum as profit would satisfy him; our workmen require more. There are materials enough in this country, and cheap enough, to drive back the inroads of the Swiss on our markets. I was down in Lancashire among the movement makers, and found the watch trade spoken of as the worst possible means of livelihood. They work from six in the morning to eight in the evening; and, as one man who makes the best going fusees in the trade told me, are in paradise at 20*s*. per week; 15*s*. being the average of good workmen. Now, if these can be found at such rates, then I say that the English trade need not be lost. The London men, whose work is true and judgment good, may still keep their prices for best work; but the bulk of our trade must be obtained by employing men whose wages approximate nearer to those of the Swiss. The trade cannot suddenly alter; the men qualified to compete with the London men cannot suddenly be created; but a slow decay must creep over London prices of inferior work while country workmen are coming into existence. In the higher walks of horology enough remains to employ all the London skill. Exactitude of time-keeping is yet unapproachable; the forms of pivots, pinions, teeth of wheels, holes, and proportions of escapements are mysteries yet unsettled; a discussion of each of which might occupy an evening. Thus have I given you my views of the trade. Education is useful; for to the enlightened mind principles are easily communicated, and invention springs more prosperously. The school of horology in Switzerland gives education to about 100 watchmakers. I do not think that that has much to do with Swiss success. General education is the means. Now our trade pay largely to the Goldsmiths' Company, and we ought to require an account of them. The funds might provide us with a School.

The opening remarks having occupied the entire evening in their delivery, Mr. A. THOMSON moved

the adjournment of the discussion till the following Thursday, 8th December: and with a vote of thanks to Mr, JONES and the CHAIRMAN, the meeting separated.

ADJOURNED DISCUSSION.

On Thursday evening, 8th December, the adjourned discussion was opened by

Mr. ADAM THOMSON, who in his opening remarks referred to the able manner in which Mr. Jones at the previous meeting had statistically shown the comparative advance of the watch manufacture in Switzerland and in England. There could be no doubt that the cheapness of the Swiss production was the main cause of its preponderance in the world's market; quality was no part of the question; and he did not believe the education of the workmen, taking it inexpediently, could in any way change or influence the demand. The question was of great importance, requiring serious attention. It was the duty of the Institute, as being the only representative of the great body of the trade, to examine the matter in all its various bearings, and not by shutting their eyes in the face of facts to think themselves free from danger. He begged the meeting to go on methodically in their search, and they would be certain of finding the solution of the question. They should firs look at the relative position of the two countries then at the stimulus and necessity for this particular manufacture in the two countries; and lastly, what is best to be done in this their own particular case. In the first place, Switzerland is a cheap country, particularly that part where the greatest quantity of watches is produced. There church rates are voluntary, and there are few taxes; the people are industrious and intelligent, lovers of order and freedom, like ourselves. England is, from necessity, a dear country; it cannot afford to disband its army, and is not disposed to swamp its church. In Switzerland the watch manufacture has been nurtured to the exclusion of almost every other. In England the watch manufacture is minor to cotton and cutlery, and represents no very large portion of the industry of the country, and yet England is the acknowledged cradle of the art. All the principles upon which watches are made, whatever part of the world they come from, were first brought out and perfected by Englishmen, with the exception of the vertical, now seldom made. Who invented that is not known; but he was not a Swiss, for even the use of a watch was scarcely known at that time in that country. He then said it was high time that English manufacturers should make up their minds on what could, and what could not be done. They could not prevent men from buying in the cheapest market, but they might be able to teach them that it would be wiser to buy better things, and it was for the English maker to show that he could make better things at a moderate advance upon the price of his competitors. He said the Swiss would be able to beat the English in cheapness at all times, unless changes took place which no man could anticipate; it would therefore be wiser to leave the cheap market entirely to them. There was no merit in making the concession, for it was nearly in their hands already. What he wished to impress upon the meeting was, that English watch manufacturers should endeavour to make a market for their own peculiar work—create a demand for sound, serviceable watches. In a few years the buyers all over the world would be assured that English work was honest, and in size and appearance in agreement with all their wants; and from what he had to commuunicate to the meeting, he hoped this could be produced at a small advance in price to that of our Swiss brethren. The sun shines for all: they will have their customers, and so shall the English. He then said, that, as he hoped he had shown them what to make, he would endeavour to show them as a friend of their's said, "how to make it."

To raise and benefit the art of horology in this country, the Council of the Institute have determined to offer a prize or gold medal for the best English made going-barrel movement that can be made in fair trade at a moderate price, no patent, no exclusive right, but that it shall be the property of the Institute, for the benefit of all. This was the first step in advance, others would quickly follow; success and good results were certain. Another suggestion has been brought before the Council; and as it will greatly influence the price and quality of English productions, it is proper it should be known to the meeting. It is proposed to give another prize to the benefactor who shall produce the best practical scale for minute measurement,—a standard gauge, by which all workshops and workmen may correspond and agree with each other, to the hundredth and thousandth part of an inch, all over the country. This will bring production to a cheaper rate without lessening the price of labour. With a minute standard gauge English workmen will be able to produce sound work, for which they will find ready purchasers in all the manufacturers who require their particular productions being made to a general fixed standard. This simple gauge will make a unity of the various workmen; and, in combination with good-sized sound movements at moderate prices, the clear heads and ready hands of Clerkenwell need have no fear of Swiss competition. He did not believe there would be any need to seek for cheap location in the cheap counties of England or Ireland, as proposed at the former meeting. He did not wish to see his fellow workmen trying to live on less solid fare in order to work at as low a rate as their brethren in the mountains of Switzerland; he would rather see the competition carried out by acting on the principle that unity is strength, and that it is well for men to band together. Nor did he agree with the wish that their wives and daughters should be taught to work at the board. It would be a poor country if all should be obliged to work. He would rather hear of his friends shipping themselves off to the colonies. There was, however, small fear of either. The Chinese said, England was a country of watchmakers; and, no doubt, a sufficient number will still find employment enough to be profitable to themselves and creditable to their country.

Mr. C. GUILLAUME.—Sir, In saying a few words on this subject I have no other pretension than to add my small share of information to what has

already been so ably said. But allow me, first, strongly to repudiate some expressions made use of by Mr. Jones on the first evening in his otherwise highly interesting and valuable statement; for even should those words have been used in the most qualified sense, they are likely to be misunderstood by the public: I allude to the terms "intrusion" and "invasion," as applied to the importation of foreign goods. On the same principle these words might be applied to British calico and iron-ware, with which you are proud to supply the whole world. It is *competition*, and nothing else. I feel the more at liberty to make these remarks, as it is well known that I am not an importer of Geneva watches, and am as much interested as most of us in the prosperity of the watch trade in Clerkenwell.

I believe, Sir, we all concur in the opinion expressed, that two of the principal causes of the state of things under consideration this evening are—*cheapness* on the one hand, and on the other, in the case of ladies' watches, *small size and elegance*. What can be done on either point? Taking first *decoration* (although of least importance), we may, no doubt, say that education has a great deal to do with *this* matter; for although we find a natural artistic skill, even in the uneducated mountain guides who carve those beautiful little chamois, still we know that a Geneva engraver or painter has had his taste cultivated and refined by proper training. Yet English artists are not in any way inferior to their continental brethren; and when they direct some of their efforts into this channel, they will, no doubt, soon achieve complete success. But a taste for arts must also be spread among the working classes, else their productions in this line will be wanting in taste and skill; or, you must have recourse to superior artists, and pay a high price. A little while ago I saw a young Englishman lately returned from Geneva, where he had learned enamel painting; but when settled here, he did not devote his labours to the decoration of watches—he became very soon, and is now, I believe, enamel painter to Her Majesty. Knowledge must become so generally diffused as to be a common thing, if we want its productions to be available. Whether it would be desirable to lead British manufacture in that direction, is another question. It has been said that the delicacy of Swiss work is due to female labour; but let me say here that such is not the case, for you will see strong, big mountaineers doing some of the finest work; and English workmen can do the most delicate work too. But adverting now to the first point alluded to, viz., *cheapness*, it seems to me that one great and perhaps insuperable cause why Swiss watches are cheaper than English watches is to be found (as Mr. Thomson said) in the great difference of taxation in the two countries, since living would in other respects be as dear in Switzerland as in England; for we are not to look at remote corners of the land, visited only by tourists, any more than you would take your returns from some parts of Ireland or Scotland, or even from some places in England, where labourers are said to earn 10*s*. a week, and curates to make both ends meet with £40 a year We must take the manufacturing districts. Well, rent is nearly the same, provisions are very little cheaper in Switzerland than in London, and articles of clothing and furniture are dearer. But where the Swiss pays shillings to the tax-gatherer, we here pay pounds, or nearly in that proportion. Whether it arises from our having run up a national debt, or is the result of a different system of public administration, is not for our present consideration; but it is a fact bearing upon the subject, that with a low taxation the Swiss get an efficient government and good national education. There lies the chief difference. In the manufacture of those goods which require the application of machinery, of iron, coal, &c. the energy and intelligence of Englishmen, aided by the natural resources of the country, have overcome, and more than overcome this disadvantage; but it is very different when a workman is single-handed, or nearly so, as must more or less be the case in watchmaking. Perhaps Mr. Jones's idea of gradually removing the manufacture to some locality where living is cheap, might help to remove this obstacle; but that plan is not immediately applicable. The other main cause of cheapness I take to be simplicity of construction in ordinary watches. This is so obvious, th has been remarked upon by several gentlemen, both here and elsewhere; it has been the subject in one of its parts, of a previous discussion, and may very likely be fully investigated throughout during the course of these meetings. Referring to the second question raised in connection with our subject, it would be difficult to say whether education alone has much to do with the result under consideration, taking it as a whole, seeing that the watch trade flourished in Switzerland *before* education had become what it now is. But what they always had, is a quickness in adopting improvements, either in the construction of the watch or in tools; for I take that view to be erroneous, which holds that there is no difference in the tools employed in both countries. Some people seem to have had an idea of wonderful machines, kept a secret by their fortunate inventors, and finding no such thing, they jump at another conclusion in an opposite direction. But here is the point; though your tool-shops may be well stocked with every variety of tools, it avails very little if those tools are not used. How is it that in the country in which useful inventions have received the greatest encouragement with the public, watchmakers should have been behindhand in some things? The cause has, I believe, been pointed out lately; and it consists in keeping too much apart—in cherishing trade secrets, so called, and thus losing the opportunity of learning more from fellow-workers than we individually could impart to others. There has been some of that spirit in Switzerland, but to a less extent; for, owing perhaps to their political institutions, men are brought into closer contact; they have met on the same benches at school, in the same *free pews* at church, and meet again at the same clubs in after-life; all which has had the effect of raising the character of the people, and developing their intellect.

Let me say also, that it would be a mistake to suppose the Swiss manufacture to be carried on in retired and secluded spots, where the population has little intercourse with the rest of the world.

The district of Chaux-de-fonds and Locle alone contains a prosperous population of about 35,000 inhabitants. They have excellent schools, colleges, roads, railways, hospitals, museums,. &c; and although they cannot have the opportunities a Londoner has, still they make the most of what they have. But I wish to add, that an Institute such as this seems to be one of the most efficient means of improvement we have, and one which, by throwing light upon these questions, will eventually bring all things right again

Mr. John Bennett would at once take it for granted that the number of watches manufactured in Switzerland was so overwhelming as to swamp the sale of second and third class English watches in every foreign market, while there was a steady and progressive increase in the sale of Swiss watches in every principal town in England Every watchmaker's experience put this beyond dispute. He had taken some pains for years to make known the principal causes that had led to this most unsatisfactory result in our watch manufacture. Apart from the better system adopted in Switzerland, and the extensive employment there of female hands, he held that their admirable system of general education was at the very root of the matter. The Swiss belief for years past had been, that to obtain perfect work it was first absolutely essential to perfect the workman. They could not expect workmen to adapt themselves readily to the altered requirements of public taste here and abroad without a high degree of cultivated intelligence. Ignorance was opposed to all change, because it was unable to see how to effect it without personal injury to the workman who had been brought up by mere rule of thumb. Thus we find a system adopted throughout the mountain watchmaking districts of Switzerland which provided all the machinery of education for even the smallest parish, and to which it was compulsory that every child of every class should give his or her attendance. Half the expense of this national system was drawn from the Federal funds, half the rest from local taxation, leaving only the remaining fourth to be found by the parent, which left him to make a payment of but about 30 francs a year for each child's education. In case of a widow's poverty even this fourth was remitted; and in certain districts, in the case of a poor parent to whom the child's labour would be remunerative, the local authorities actually paid to the parent a sum in lieu of what the child would have earned. Nor was this education limited to the bare rudiments of an English common school system, but the knowledge and practice of mathematics, of a foreign language, and the elements of natural philosophy, embracing mechanical science, were ably and effectually taught, as well to girls as boys. Beyond this a special regard was paid to the cultivation of all that would refine the taste or elevate the character of the future man or woman. Thus vocal music was taught from notes for half an hour morning and evening, daily; and every school was made a school of design, where the knowledge of drawing and a taste for art were systematically imparted to every child. Who could wonder, then, that Swiss watches were found, not only cheaper in cost, but immensely distancing our own products in beauty and elegance? Surely it is high time for Clerkenwell to take a leaf out of the Swiss book; and this might be done if the members of the Horological Institute would earnestly support those members of the trade who refused to shut their eyes to the existence of facts by which alone our prosperity could be secured. It was worse than child's play to endeavour to conceal these obvious realities in a fog of figures, however elaborately prepared. Nothing would now avail but an entire change of system, the employment of the female hand, and the highest possible cultivation of the rising generation. This, surely, was the business of the Horological Institute. Without this we must be beaten out of the market by the wiser Swiss; but with such a change there was every hope that English skill, capital, and enterprise would retrieve our present declension, and maintain in this as in other manufactures our accustomed superiority.

Mr. E. J. Thompson said, he was extremely obliged to the Chairman for calling upon him to say a few words upon this occasion. He was the more anxious so to do because the gentleman who had preceded him (Mr. Bennett) had more than once pointedly alluded to him in the course of the remarks he had made, implying that he had attributed to him a want of consistency in the course he was publicly pursuing with regard to this question. Now, he would once for all say, that if any word he had said at Amwell-street or elsewhere could possibly be construed to be personally offensive to that gentleman, he offered all apology. But, having said so much, he would claim to say also that the meeting at which those expressions were used was a purely private one, held in a private room after the public meeting was concluded, and he might therefore complain of the worthy gentleman having alluded to the matter upon this more public occasion, and the more so as they were not met to bandy about imputations, but to discuss the most important question connected with their trade. He must say, that it was singular that Mr. Bennett, who went perambulating round the country, addressing the public upon it, should come down to that the head-quarters for discussing the question, and then, instead of speaking to the subject, occupy nearly the whole time of the meeting with a dissertation upon education, which they all felt the importance of, but having nothing to do with the subject before them, that subject being how they should best compete with the Swiss, and not how should the next generation do so, the question of education as put by that gentleman being one affecting the next and succeeding generations chiefly.

He felt rather surprised that so little had been said upon the English side of this question. Certain statements had been made as to the greatly increasing quantities of watches produced by the Swiss; Mr. Bennett averring, without any statistics, that the manufacture of Swiss watches was at the rate of 1,500,000 per annum, and Mr. Jones shewing that 500,000 was nigher the quantity. Mr. Bennett might object to the latter number as not being sufficient; but he well remembered that Mr. Jones at their previous meeting adduced every statistic he could gather, and, after making large allowances for the supply of other continental nations and for the exportation through the

German free ports, he at least convinced him, as he believed he did the meeting generally, that by far the largest quantity was sent through the custom-houses of France for the supply of that and, through it, of this country: and that quantity being registered and compared with the probable consumption of other countries, an average was arrived at of 500,000, which appeared to be vastly nearer the truth than the other statement founded upon assumptions entirely. He should be sorry to under-rate the commercial importance of the Swiss manufacture; he trusted that the manufacturers of both countries would continue in a spirit of friendly emulation to carry on their competition, assisting as far as in them lay the advancement of their common trade; but they must look at facts in connection with this subject. The worthy gentleman who preceded him had said over and over again, that the English trade had been regularly decreasing since 1851—(Mr. BENNETT, "Yes"); and even the opener of the debate at our last meeting seemed to favour this view. Now, he would say boldly in answer, that the English trade never was so flourishing during the whole of its history as it was in the years 1854, '55, and '56 (cheers); he defied any one to disprove this; and though gentlemen who were engaged in the retail trade might not be aware of it, he would undertake to say that every one connected with the manufacturing of watches in any one of those years would bear him out in this statement. It had since then been suffering from the rebound consequent upon the too great extension of trade induced by the Australian gold discoveries—from the American monetary panic, which had had immense influence upon their manufacture—and from many other causes, such as their own commercial panic in 1857. They were now slowly, but surely, recovering from the effects of all these, and as surely would their trade again revive, and all branches of it be as fully employed as ever they had been. He was well aware that they could not make so cheap a watch as the Swiss; and the cause of that had been ably stated by their friend Mr Guillaume; but he would say this, that in all watches above the common qualities, if they added the extra value of the gold in the cases, and took into account the greater strength and smaller cost of repairing the English watch, that then the difference of price was in favour of the English article. Another cause—and he believed in this country a very great cause—of the large sale of the Swiss watches arose from the fact that the retailers sold the Swiss watches at a smaller proportionate profit than they did English work. But, notwithstanding this and every other cause, he had no fear for the English trade; there were important markets throughout the world where the English watch was in great demand. He would urge them not to endeavour to compete with the Swiss in their cheaper articles, but to exert all their energies to keep up the character of the English watch, by continued and increasing excellence of workmanship, and by the adoption of every measure tending to cheapen its production without deteriorating its quality; then, though there might be seasons of great prosperity followed by seasons of great adversity, he should not, in the midst of the latter, have any conviction stronger than that their trade would again revive with increased and increasing prosperity.

Mr. JONES, in replying, said,—I wish to observe that I am not a volunteer in this discussion; I reluctantly yielded to the request of the Committee, and have given you the results of my investigation, and the authorities I rely upon. To describe my observations as a fog of figures, seems to me inconsistent on the part of one who uses figures to support his propositions. That figures may be confused into a fog, I know; but I think I may appeal to you in favour of the intelligibility of my statistics. I still abide by the conclusion, that the cause of Swiss cheapness is not to be found in their superior education. In their Horological Schools the number of scholars does not exceed 100, and that is not a number sufficient to inuflence a manufacture. With reference to their primary education, the report of our Member of Legation to the Foreign Secretary is, that though the law of general education exists, there are no means of adequately enforcing it; and particularly in the watch district is the education of children slighted, from the desire of parents to gain some pecuniary benefit by their early application to work. That education is not good I would be far from asserting, not only as a means of obtaining money, but as furnishing a constant feast of pleasure from the understanding of every object around you. Education converts life into happiness. But the mere talking about it, without practically assisting in it, is neither in good taste nor good sense. Notwithstanding Mr. Guillaume's objection to the word "invasion," I must still retain it. I know that the highest form of life is the recognition of all men as friends irrespective of country; but, as long as the competition of race is necessary for the growth of the different capabilities of men, I must abide by the principle of patriotism, waiting expectantly for some impulse to human exertions which shall secure equal results from higher principles.

On the 21st February a Paper will be read at the Institute by Mr. R. SCHWEIZER, on the ART DECORATION OF WATCHES in Switzerland and in England; and on the 6th of March a Discussion will take place on the same subject.

ANNUAL DINNER.—As will be seen by an Advertisement in our first page, the Annual Dinner of the Members of the Horological Institute and their Friends will take place at the Freemasons' Tavern, Great Queen-street, on Wednesday the 29th instant, when VALENTINE KNIGHT, Esq., the President, has promised to take the Chair.

ture where it was before, it gained 10' in 24 hours. I repeated the trial, which furnished a new advancement, less considerable than the preceding, and the same with a third, &c. Other watches, instead of gaining, on the contrary would lose by the preceding operation, which sometimes also does not produce any effect. By reflecting on these subjects, I conceived that there happened here some effect similar to those observed in the elaterometer. It might very well be, that the springs, or the regulating springs (for I made this trial by different methods) experienced some change of figure by heat which would augment or diminish their strength; whence I concluded that it would be necessary to take particular care that these springs move very freely, and that they do not receive the smallest constraint in their application to the balance. With this view I made the pieces *d d* (Plate III *fig.* 6) capable of receiving all the requisite situations that the spring might be attached without experiencing the least constraint. By their first motion they would move backwards or forwards in their groove to receive the springs; we might then raise or lower them at pleasure by turning them on the screws *d*, *d* (Plate III.) by which they are affixed to the frame: lastly, the part where the spring is attached turns itself on a pivot, in order that this spring might be applied without changing its figure in any respect. When all these precautions are taken, we fix all the parts by their screws. By means of these pieces we diminish this effect greatly, if we do not totally destroy it; and we completely annihilate it by successively heating and cooling the machine until it no longer exists. Without these precautions it is only by chance that we can produce a good marine watch.

Article VIII.

Means used to prevent the effect of shocks and different positions.

These shocks may be opposed to the regularity of our marine watch by two causes: 1st, because the regulator in receiving its own motion, that is to say, the motion that the motive force of the watch keeps up, may be augmented or diminished, &c.; 2dly, since by the repeated agitations of all the parts of the machinery, especially those of the regulator, the situation, the form, and the texture of these parts may be changed; whence arise errors so much the more important because, instead of being transitory, as others are, they would only cease when we had applied the remedy to the changes as they happen. The methods which appeared to me proper to prevent these inconveniences are—1st, to render all the parts of the watch as solid and as unalterable as they can be made; 2dly, to suspend the machine in such a way that it may receive little motion from shocks; 3dly, to diminish the effect of this motion as much as it can be done; lastly, to arrange things in such a manner that this motion when received may not be preserved, but may cease, on the contrary, as soon as possible. To fulfil these different conditions, I took care not to give my spiral springs too great a magnitude or mass with regard to their strength. M. Daniel Bernoulli recommends in his *Memoire* to make them very large; but, having applied some of them to my watch, I presently perceived that agitations a little considerable made them move and vibrate not only according to their length, but even in their width; whence I concluded that there was a mean term to be chosen in the size of these springs. After some experience, I fell upon that point of magnitude in the spring where all the vibratious are exactly isochronous* without being affected by considerable shocks. Nothing could appear more opposite to that solidity which is so necessary in the parts of the regulator, than the harpsichord wire by which it is suspended. Although its strength be such as to sustain a weight fourteen times greater than the balance without breaking, nevertheless it was much to be feared that it would not withstand violent shocks (which happened, in effect, before I had taken the precautions which I am going to mention), or at least that it would lengthen. To prevent this inconvenience, I attached the upper extremity of this wire to a spring, *x x* (*fig.* 7, Plate I.), sufficiently strong to keep the wire and the balance suspended, and elevate it to a fixed point above, against which this spring presses, and is stopped; by this means it is no longer the wire which sustains the balance in great shocks. Then the suspension spring, which could only raise a weight a little greater than the balance, gives way, and the extremity of the lower pivot of the balance touches and rubs during the moment of the shock on a plate, as is done in common watches when they are laid down. An essential thing to determine was the magnitude of the vibrations. I acknowledge that the true place where we might find this with most success would be a seaport. M. Bernoulli recommends that they should be very small; but I feared then that shocks would have had a considerable effect on them. I have therefore made the balance describe an

* See Article II. of Part II.

Plate IV., fig. 1.

arc of about 100 degrees in the long vibrations—that is to say, when the watch is just wound up—which is reduced to 90 after the watch has been going 24 hours. In other respects I have followed the principles of M. Bernoulli (*ibid*) who requires that a considerable motion of the balance should produce little change in the figure of the spring. After having put the regulator, by the proper disposition of its parts, as much as possible out of the power of shocks, to fulfil our views entirely it is necessary to find some method of rendering these motions as small as they can be, the least abrupt, and of as short a duration as possible. This is what I have done by the suspension which I have given to the new watch. The motions which it may receive can only be either horizontal, vertical, or in a direction compounded of these two. To compensate the first, which would particularly affect the spiral springs, I have suspended and rendered my watch moveable on two axes, A A (*fig.* 1, Plate IV.), adapted to a frame or strong paralellogram of copper, A B, A B, which itself, as well as the watch, turns on two other axes, B B, fixed to the box which contains the whole machine.* By this means the watch forms a kind of pendulum, at the bottom of which are placed the spiral springs. When therefore they receive a shock, we see at first sight that it is the points of suspension which feel it, and that the lower part of the pendulum, or the watch, remains almost fixed at that moment; this pendulum then redescends by an inclined plain to the vertical, whence it was removed by the shock, and that by a gentle motion, progressive and slow, which can neither affect nor derange that of the spiral springs.

These motions, although rendered more gentle and infinitely less prejudicial, nevertheless, cannot be otherwise than contrary to the accuracy of the watch. If they were of long duration—that is to say, if the oscillations of this watch, forming a pendulum, continued like that of the common pendulums, this construction would then have had another more considerable disadvantage. These oscillations would increase by a continuation of shocks; whence it would happen that the points of suspension would be worn; that the watch would be found, in a great number of instances, in situations very remote from the vertical (which is the most advantageous situation, being the one in which it was regulated); and that the sum of the motions, now rendered less contrary to truth, would be considerably augmented. I have prevented this inconvenience—1st, by gentle friction springs acting near the points of suspension on planes or large surfaces, which, with a sufficient resistance to diminish considerably the oscillatory motion, are very little subject to wear, and nevertheless permit the watch to move on these axes; 2ndly, by a pad B B, (*fig.* 2, Plate IV.) formed at the bottom of the case which contains the watch, and by cushions which are placed round the sides of the box, in such a way, that in great shocks the lower part of the watch meets obstacles that are supple and moveable, which extinguish the motion by their softness, and prevent it from continuing. But a very essential

* A watch suspended in this way is said to be hung upon gimbals. Berthoud (*Eclaircissemens*, page 33) attributes the contrivance to Cardan; but I have seen an old work on mechanics, of much earlier date than anything of Cardan's, where this suspension was proposed for a carriage to convey wounded soldiers from the field of battle, or from *one place to another*.—T. S. E.

Plate V., fig. 2.

point to render the motion of the balance unalterable by shocks is as M. Bernoulli recommends (page 39 of the *Researches* above cited) that it be of equal weight throughout This is one of the considerations which has induced me to use two opposite spiral springs in my watch,* both opening and shutting together in order that each spring may have one half less mass than if, being single, its height were double, and in order that, this mass being more equally distributed around the centre of motion, the regulator might not be exposed to gain or lose by lateral shocks. The advantages of this method have been confirmed to me by a number of experiments. By means of these precautions we may turn the watch rapidly, or make it vibrate quickly on its suspension, without any sensible difference resulting in the arcs of vibration. There is but one foreign motion that can derange it; and that is the one which it may receive circularly on the axis of its regulator. But the machine being adapted to the vessel by means of four fastenings, fixed at the bottom of the box, it is impossible that it can receive any thing of the kind. Moreover, I have thought it best (on the authority of what has been observed by M. L'Abbè Chappe, and on what has been said by M. Bouguer, p. 214 of the *Manœuvres de Vaisseaux*, that the inclination of a ship is much too great when it is from 18 to 20 degrees), to dispose my machine, not for inclinations which rarely take place, but for a mean term. It has therefore the liberty of describing on its suspension, and in its box, only 15 or 16 degrees; this may go as far as 18 or 20 by the giving way of the cushions and pad, if the weight of the watch press them at any time.

(*To be continued*)

* Sully used two spiral springs in his watch. See *Description Abregée*, pages 175 and 177.—T. S. E.

ACCELERATION OF RATE IN NEW CHRONOMETERS.

To the Editor of the Horological Journal.

Sir,—Several chronometer makers have made public their opinions in your Journal upon the cause of the acceleration of rate in new chronometers; but I think that none have as yet given the true reason. If a piece of wire be bent with pliers or other tool, one can easily imagine how the outer particles of the wire would be separated more than the inner ones, and that by constant bending and unbending these particles would gradually arrange themselves, and the chronometer would continue to gain on its rate until the wire had reached its maximum strength. Now, if it were possible to wind a spring on a block so that the wire would maintain its position without the application of heat, that spring, though soft, would continue to accelerate for some considerable time, until the particles had arranged themselves, were it not for the relaxing of elasticity of the spring, which would more than counterbalance the gaining on the rate, and hence the chronometer would lose; but, by making the spring red-hot in hardening, the particles would be driven very far apart, as compared with the distance they were from one another before, and upon cooling would arrange themselves at once, and if the spring were left then no acceleration of rate would take place; but, instead of that, the chronometer maker takes his pliers and bends the first and last turns of the spring in towards the pendulum stud and collet until the spring be set true with the balance staff, thus creating afresh the error which was before destroyed in the hardening.

I have, after great difficulty, succeeded in

totally destroying this source of error, by making a spring that requires no bending at all after hardening. The spring is made like the ordinary chronometer spring, but with three or four flat spiral turns at the top and bottom reaching to the stud and collet, so that it may be pinned in without any bending. I have placed specimens of this spring in the Museum of the British Horological Institute. Your's, &c.,

J. Hammersley.

RESILIENT LEVER ESCAPEMENT.

To the Editor of the Horological Journal.

Sir,—In the concluding article of "What is Horology," in No. 17 of the Journal, a remark is made by Mr. Hislop relating to the bankings in detached lever escapements, the defect of which (acceleration), he says, "is *partially* remedied in a modification by Mr. Cole." Such statement appearing derogatory to the completeness of my improvement, I wish only to prevent wrong impressions, by saying that all acceleration on time, and liability to injury, consequent to the abrupt bankings of ordinary lever watches, is *perfectly* remedied by my principle of the resilient lever, in which there is no banking error, as certified by many competent watchmakers who have adopted and approved the principle.

The insertion of the above in No. 18 of the Journal will much oblige, Sir, your's very respectfully,

James F. Cole.

ABRIDGMENTS OF SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

Printed by order of the Commissioners of Patents, and published at the Great Seal Patent Office, 25, Southampton-Buildings.

(*Continued from page* 59.)

1812, December 9.—No. 3620.

SMITH, Samuel.—"The escapement wheel, which "is made of brass, steel, or other metal, having five "teeth, more or less, strikes vertically upon pallets "made of brass, steel, or other metal, stones or not, "with ruby or other stone, in a horizontal position, "on whose arbor is affixed a wheel to drive a pinion in "the balance, to which balance is affixed the pen-"dulum spring to render the motion at once steady "and secure; the train of the movement may be "made to show seconds or parts of seconds at the "pleasure of the manufacturer or wearer."

[Printed, 3*d*. See Repertory of Arts, vol. 22 (*second series*), p. 202.]

1813, March 13.—No. 3663.

RENTZSCH, Sigismund.—Hydrostatical or pneumatical chronometer. "It consists of a hollow glass "ring, about four inches diameter, which revolves on "an axis, and contains mercury and air, or any other "fluids of different gravities, hermetically enclosed; "the heaviest will occupy the lowest part. In the "upper part, which contains the light fluid, there is "a partition, with a small perforation through it, made "of glass, or any other material that has no affinity "with the enclosed fluids. The moving power is a "weight attached to the axle by means of a cord, "which produces a circular motion at the same rate that "the light fluid is forced though the aperture in the "partition by the pressure of the heavy fluid, which, "by the force of gravity, endeavours to ascend in the "same situation it held before the application of the "weight. The time is indicated by a graduated "circle on the glass ring and a fixed index."

[Printed, 3*d*. See Rolls Chapel Reports, 8th Report, p. 26.]

1813, August 9.—No. 3732.

WESTFIELD, Robert.—Improvements in the horizontal escapement, by making the stems of the horizontal wheel of different altitudes, so that the teeth of the wheel in its revolutions act upon different parts of the pallets of the cylinder, and the diversity of action may be increased to the number of teeth contained in the wheel.

[Printed, 3*d*. See Rolls Chapel Reports, 8th Report, p. 26.]

1814, November 17.—No. 3854.

MASSEY, Edward.—1. Relates to escapements, the principal feature of which is a lever with equal arms, which is on the same axle as a wheel which is connected by certain wheelwork with the swing wheel. The principle is varied, and the specification contains descriptions of escapements for pendulum regulators, marine box chronometers, and of detached escapements, and cylinder escapements.

2. Winding up fusee or other watches by means of the pendant. The pendant being pushed in, pushes in a small pin, which causes, by simple mechanism, a rack to move forward a certain distance, and thus partially wind the watch up, by the aid of a ratchet on the fusee axle, or going barrel, as the case may be. On withdrawing the pressure from the pendant, a spring returns the rack to its former place ready for a further winding up, and so on till the watch is wound up, a click preventing any unwinding.

3. Relates to compensation curbs of different constructions, the curbs being made with delicate springs at the end to press the curb against the compensation piece, and thus keep them in contact with each other.

4. Relates to a method for telling the day of the month, consisting in having the case of the watch divided from the centre into seven equal parts, on which are engraved the days of the month from 1 to 31, and having a moveable circle with the letters of the days of the week on it; the moveable circle

month. Similarly the moon's age

[Printed, 11*d*. See Rolls Chapel Reports, 8th Report p. 109.]

1817, February 1.—No. 4097.

WALL, WILLIAM.—The vibrations are performed with two escape wheels, one fixed on the fourth wheel arbor, the other on the fifth wheel arbor, and which are supported in opposite revolutions by the fourth and fifth wheels acting on the said arbors, thus con- through their actions on the pallets or cylinder, formed in the rib or staff of the balance.

[Printed, 3*d*. See Rolls Chapel Reports, 8th Report, p. 116.]

1817, February 20.—No. 4103.

LITHERLAND, RICHARD. — Escapements. 1. When the balance is at rest, the detent locks the pallet wheel. one way, the lifting pallet, strikes the detent pallet (with detent the tooth of does not unlock it. As soon as the lifting pallet or pin has passed the detent pallet, a spring, acting on the directing pallet which is on the same pivot as the latter into As the the other way, and unlocks a tooth

2. For chronometers or marine time-keepers, instead of the directing pallet and detent pallet, the patentee contrives the detent pallet and the detent to elastic steel, made fast at "

3. or rod, composed of "lamina "of brass and steel," to act on the balance spring to adjust the motion in heat and cold.

[Printed, 5*d*. See Rolls Chapel Reports, 8th Report, p. 120.]

1817, May 22.—No. 4129.

HUNT, SETH.—An escapement, of which the only new part is the form of a lever, which is in the shape of two arms at right angles to each other, the long arm working on an arbor about two thirds down the lever from the the short arm one of which, when the balance is set in motion, as to continue the motion, while the teeth of the escape wheel. When the balance is set by means of a pallet, disengaged confined it, and is pressed down by the It thus releases the escape wheel from confined it, and the wheel acts as aforesaid on the last-mentioned tooth of the short arm, and brings the lever to its former position.

[Printed, 5*d*. See Rolls Chapel Reports, 8th Report, p. 119.]

EQUATION OF TIME TABLE

For FEBRUARY, 1860.

TO CORRESPONDENTS, &c.

S. LONG'S communication has been received and will be attended to in our next Number

*** Anonymous Communications cannot be attended to.

London: Printed for THE BRITISH HOROLOGICAL INSTITUTE; by R. Great Sutton

THE BRITISH HOROLOGICAL INSTITUTE,

35, NORTHAMPTON SQUARE, CLERKENWELL, E.C.

Office Hours, from 2 *till* 10 P.M—*Reading Room open from* 7 *till* 10.

The object of the Institute is to develope the science of Horology, by affording facilities for the acquirement of useful knowledge in the art, by promoting improvements in the manufacture, and by fostering a spirit of kindliness among those who are employed in its various branches.

It is composed of Members who pay an annual subscription of Twelve shillings, or a half-yearly subscription of Six shillings. Annual or Half-yearly Members residing beyond the twelve miles circle, one-third less. The Apprentices of Members are admitted to the Reading-room and the use of the Library, and also to the Meetings, at the rate of Three shillings per annum. A donation of Five guineas constitutes a Life Member, and Ten guineas a Founder.

It offers to its Members—

1. The use of a Library in course of formation, and a Reading-room supplied with periodicals and papers.
2. Periodical Meetings for conversation and discussion on all subjects having reference to the art of Horology.
3. The reading and hearing Original Papers and Lectures on Horological and Scientific subjects.
4. The use of a Collection of Models, Drawings, &c., also in the course of formation.
5. A Monthly Illustrated Journal, delivered free to each Member, containing matter interesting to those engaged in Watch and Clock making, and to which all are invited to contribute either letters, extracts, or original papers.
6. Country Members, in addition to the Journal and the free use of the Library, Reading-room, Models, &c., &c. during office hours when in town, have the privilege of addressing their correspondence to the Office of the Institute, to be kept for them or transmitted.
7. The exhibition of Specimens of Workmanship, Tools, or Instruments connected with the Art.

The British Horological Institute, in fact, is intended to be an Association of the most practically useful kind to those connected with Time and Time-keeping, and is also calculated to be a means of promoting a spirit of interest in the calling, and a wholesome pride of its high scientific character, which shall have the best results to all concerned.

To carry out these objects efficiently and permanently a large number of Members is required.

Further particulars may be obtained of the Hon. Secretary, at the Office of the Institute, 35, Northampton Square, Clerkenwell, E. C.

☞ *Members are informed that they can receive a Ticket of Admission to any of the ordinary Meetings of the* Society of Arts *during the season, by applying to the Hon. Secretary.*

THE BRITISH HOROLOGICAL INSTITUTE.

CLASSES FOR INSTRUCTION IN GEOMETRY AND DRAWING.—The Council, as will be seen by an advertisement in our first page, have made arrangements with a highly qualified Master to give Instruction in Geometry, and in Mechanical and Ornamental Drawing as applicable to Horology, to such Members of the Institute as may be desirous of availing themselves of such means of improvement. Lessons will be given, at the Rooms of the Institute, in Geometry once a week, and in Drawing twice a week, as soon as the names of Twelve Pupils shall have been received.

The Fee will be *5s.* per quarter for the Geometry Class, and *7s.* per quarter for Mechanical and Ornamental Drawing; or *10s.* per quarter for Pupils joining both Classes, payable in each case in advance.

The Drawing Master's Pupils Specimens of Mechanical and Ornamental Drawing may be seen by application at the Institute.

TIME BY ELECTRIC CURRENT FROM GREENWICH. — The Council have received the following Communication from the Secretary of the London District Telegraph Company:—

"LONDON DISTRICT TELEGRAPH COMPANY, LIMITED,
58, *Threadneedle Street, London, E.C.*, 21*st Feb.* 1860.

"GEORGE MYLNE, Esq., *Secretary, British Horological Institute.*

"Dear Sir,—In answer to your enquiries of the 14th inst., I beg to say, for the information of yourself and Council of your Institute, that if the Trade generally give this Company a fair encouragement by subscribing for the hourly receipt of Greenwich mean time, I have not the slightest doubt but that my Directors will grant to the Institute, free of charge, the wire necessary for the receipt of the Time, and would lead the same into your Building.

"The method to be adopted by this Company will be the reserving wires specially for the purpose, no other use being permitted to them. The signals will be hourly received at this Station direct from the Observatory, the batteries being under the control of the Company's Engineer here. A relay will be fixed here, which will transmit a current from independent batteries along the various routes simultaneously with that from the Observatory.

"I shall be happy to afford you any further information you may require.

"I am, dear Sir, your's faithfully,
"A. OGAN, *Secretary.*

A DISCUSSION will take place on the ART DECORATION OF WATCHES in Switzerland and in England, as previously announced, on the 6th of March instant, at the Rooms of the Institute, at 8 P.M.

Members of the Institute, and the Trade at large, are again earnestly requested to lend their co-operation in the promotion of Horological science by the reading of Papers or the delivery of Lectures on any subject connected with Chronometer, Watch, or Clock-making with which they may be specially acquainted; it being considered that information upon any branch of Horological manufacture must be interesting to the Members generally. Persons so disposed are requested to forward their intentions addressed to the Secretary at the Institute.

Mr. MAY'S LECTURE.—On the Chronometer and its Adjustments.

On Tuesday, 6th December, a Lecture was delivered to the Members of the Institute, by Mr. Samuel May, *On the Chronometer and its Adjustments*, as previously announced by advertisement, at the Amwell-street Schoolrooms. The chair was occupied by Mr. Cole, who, in opening the proceedings, read a letter from Mr. Valentine Knight, regretting his inability to attend.

Mr. May, after some preliminary observations, said that the subject was surrounded by several difficulties. There were many present to whom the very elementary principles of the construction of a chronometer were a mystery, whilst there were others to whom its details were perfectly familiar. A great deal of matter for observation was lost from want of knowledge of those elementary principles. Many things caught the common observer which were at once understood, appreciated, and pursued. The artist, by a dash of the pencil, could give the canvas a startling idea. It was just the reverse with the chronometer. Within a narrow compass, probably of six inches, was shut down an elaborate effort which had occupied many years in achieving. Into that little space was brought the results of the labour and study of the lives of several men. If they looked at the matter as though they were rising on some hill, they would find that at every step they gained a wider range of vision until they reached its summit. So was it with the construction of the chronometer. The greater the accuracy they attained the more was developed of the errors required to be corrected. There had been an amazing amount of toil and ingenuity brought to bear upon the improvement of the instrument; and in that respect they should be prepared to render honour to whom honour was due. Probably there was nothing which exhibited the same amount of merit, or which had contributed more largely to the general advantage of the commerce of this country and the safety and well-being of so many lives, as the chronometer. If the artist and musician were deserving of praise, surely the men who devoted their energies and intellects to such an eminently useful work were entitled to their reward. As he had said, in proportion as they approached to correctness in the measurement of time had they been led to consider the necessity of further improvements. Just as the perturbations of Uranus led to the conception that another planet must be near its orbit, so had the correction of one error in the measurement of time led to the appreciation of another in its neighbourhood.

It was not a part of the lecturer's object to describe the very early modes of measuring time; his desire was to look more particularly at the marine chronometer, so called because of its adaptation more especially to nautical purposes. Being portable, and consequently capable of being carried to sea, if its performance could be relied upon, then the time of a known meridian could be always known, so that the difference in time would give the difference of longitude or the change of position east or west of the known meridian.

If they looked at the history of human progress they would find it made up of three essential elements—the moment, the man, and the result, either together or resulting from each other. In the early ages of the world chronometers were not needed, and therefore it was no wonder that they were not sought for. If they carried their minds back to the time when that Italian, Columbus, started to seek a new world, they would see how the moment, to which the lecturer had referred as one of the great elements of human progress, was coming. All that was practically known of navigation till then consisted of little more than mere coasting trips, the vessels being seldom out of sight of land, or the soundings by the lead line. Instruments for measuring the time for nautical purposes were not then required. About the time that Columbus started another bold navigator pursued a southward course, and accomplished the first circumnavigation of the globe. The spherical shape of the earth was a settled fact in the minds of all educated men. When astronomy began to be more developed by Tycho Brahe, then the necessity for such instruments as the chronometer began to be apparent. Many were the efforts then made to produce instruments to measure the time for astronomical observations, the earth's revolution on its axis, and the preservation of the time of a known meridian, without which the navigation of the trackless seas could not be conducted with any certainty of success. Columbus, Gama, Anson, and Drake, who by their enterprise and energy succeeded in circumnavigating the earth, found the difficulty they had in ascertaining the longitude. The astrolabe of Drake, to be seen at Greenwich, would give some idea of the instrument he used to find the latitude, but he had no means of preserving the known time of the Greenwich meridian, and therefore to ascertain the longitude was very difficult to him and others. The want became imperative. The moment brought the need of a time-keeper possessed of sufficient accuracy to determine the longitude at sea. From that time all the great master minds in the art of time-measuring, who have exhibited such wondrous invention and perseverance, then applied themselves to the perfection of the chronometer. Galileo conceived the idea of applying the pendulum to the time measurer then used for the purpose of astronomical observations. Dr. Hook invented the pendulum spring with the express idea of finding the longitude at sea by time measuring. It was marvellous to find that when the moment came the men were not far from it. The result did not always follow immediately; but the pressure once put on, the men were found suited to the moment. Upon the wall of the room was a drawing, one of the earliest authenticated, of a wheelwork clock of De Vic's made about the year 1370. However strange the statement might appear, he would venture to say that they had never got beyond that. De Vic there solved the great problem of the mechanical arrangement for measuring the earth's revolution upon its axis. There were but two powers which they knew of—the law of gravity, which brought all falling bodies to its centre, and gave a motive power in the descent; and the

system employed by De Vic, a falling weight being his motive power—the same, in fact, as the elasticity of the spring seeking to relieve itself from the unnatural tension and go back to quiescence. De Vic communicated his power through a series of toothed-cut edges. The entire principle of the chronometer was there; and whatever had been done with it since was only to give a more accurate government to the balance, the means by which the motive power escaped. There were many changes before the clock of De Vic assumed the form of the chronometer on the table, but still there were the motive and the governing powers. It was to that form of clock that Galileo conceived the idea of applying the pendulum. As the lecturer was speaking upon portable time-keepers, he would only say a word or two upon fixed time-keepers. Great irregularity was perceived in such an instrument as that of De Vic. In a clock with one hand, however, a little error was not very readily detected; but when men wanted to measure time more accurately, it would be very apparent, and therefore Galileo found the desirableness of applying the pendulum.

They had now glanced at three important points in the history of the subject before them —De Vic's clock in 1370; Vasca de Gama's circumnavigating the earth in 1497; and Galileo's pendulum about 1576. The latter inventor investigated the power of falling bodies, and found the advantage of the pendulum, which he applied in the early part of the seventeenth century. Many improvements were subsequently made; and about 200 years ago Dr. Hook invented the balance-spring, or fine hair-spring by which time-keepers should be regulated, and the power more accurately preserved and governed.

As Hook suggested the spring to govern the governor, so it was found that something was required to govern his governor. Indeed, all that has been done subsequently has been to correct Hook's corrector. It was constantly undergoing change. It is scarcely possible for an alteration of temperature to take place without materially affecting it. The vibrating of the balance would be materially influenced by an increase or a decrease of tension, by change in the oil, and by other circumstances, which produce irregularity in time-measuring.

The old crown-wheel was the only escapement from the days of De Vic to those of Graham, who introduced the dead-beat escapement, so beautiful and simple, and so deserving of the highest praise. The works of Graham, Harrison, and Mudge could not be contemplated without seeing the self-sacrifices they made, such as few men were called upon now to endure. Graham's invention has never been, and is not likely to be, superseded. Harrison, who was but a carpenter, was introduced to Graham, and learned from him, no doubt, a great deal of that which he afterwards put into practice successfully. Harrison applied the laying together of two metals different in their expansible properties; thereby producing not expansion in a straight line, but in a curve, and by this means he so far corrected the errors of Hook's balance spring as to produce a chronometer within the limits required by the act of parliament, for which he received £20,000, after 40 years of persevering effort. But he also dealt with the escapement, the friction in which caused irregularities. Such were the difficulties under which men laboured at that time, that they had not only to make all their movements, but all their tools also, doing by hand what is in the present day done by machinery. The first dividing or wheel-cutting engines were made by Dr. Hook, a professor of mathematics in Gresham College, in the time of Charles the Second; but wheel-teeth being rounded by hand they were not always equal, and consequently the motive power was irregular. Harrison's mind was impressed with the fact that if he could make an escapement that would be subject to no irregularity, he would have a correct motive power; and hence he formed an escapement which gave an impulse to the balance independently of the motive power. With an escapement having a separate spring, and a compensating curve, he obtained such an accuracy in the correction of Hook's corrector, as to gain the Government reward; but he did not make a second one. His son-in-law tried from his drawings, and failed. Mudge followed in the footsteps of Harrison, by whom he had been taught. He tried to correct the escapement, but failed in doing so. An excellent model of his celebrated remontoire escapement, belonging to your Museum, is now on the table.

The lecturer then described, as the next important feature of progress in the art, the application by Le Roy, about the middle of the 18th century, of a compensating balance to the chronometer, as illustrated by a large diagram on the wall, and by which he explained the effects of the changes of temperature upon a column of mercury, compensating thereby the variations in the balance spring. But the columns of mercury could never be kept from separating in its particles, and consequently accuracy was destroyed.

The next step was that introduced by the early Arnold — the applying the compensation - balance by means of lamina to contract or expand the balance, increasing or decreasing its circumference according to the increase or decrease of the tension of the spring. Arnold applied also with his balance the cylindrical spring; and although not successful, his time-keeper was superior to Mudge's. With that spring, his balance, and the detached escapement (known as the *waggon whip*, from the curve of the detent spring), Arnold's chronometer went remarkably well. This was getting a little higher up the hill, gaining a wider range of vision, and a further development of something yet to be done.

Earnshaw originated the mode of the detached chronometer escapement as it is now used, and which would be a standing monument of his genius as long as the trade lasted. A fine working model of this escapement, also from the Museum, was on the table, in action. He also improved upon Arnold's balance, turning in the lathe what Arnold formerly bent by hand and attached to a plain balance. How such men have left the footprints of their work upon the path they trod! But it was the heavy foot of poverty, rather than the elastic tread of shop-keeping prosperity, which left its mark behind. Earnshaw was a poor man; and it was when he was finishing watches at a guinea a piece, and had a difficulty in maintaining his family, that his ingenuity developed this inven-

[illegible] 25	107	[illegible]
1857 21	103	82
1858 23	98	95
1859 31	105	74

Mr. SCHWEIZER.—On the Art Decoration of Watches.

The following interesting Paper, *On the Art Decoration of Watches in Switzerland and in England*, was read by Mr. R. Schweizer, at the Institute, on the evening of Tuesday the 21st ult. Mr. J. F. Cole in the chair.

I come before you on this occasion with reluctance, feeling unable to do justice to the subject. The time allowed me has been too short to admit of the study which the subject requires, and I wish one of my English colleagues had been chosen, who, by a thorough knowledge of the language and other advantages, would have been able to place before you a more elaborate statement.

Engraving (from the Greek word γράφειν) is the art of cutting figures or ornaments either in wood, metal, or stone. The arts of wood, stone, and metal engraving are of very ancient origin, and preceded those of sculpture, drawing, and painting.

The Greeks had their crests engraved on precious stones, wherewith they made impressions on wax. The Egyptians, the Indians, the Romans, and many others knew the art of engraving, and carried it to a high state of perfection.

It is supposed that copper engraving was practised by the Chinese long before the art was known in Europe. Their printing consists in engraving. They engrave their books on blocks of wood, and then take impressions. Unquestionably *wood engraving* is of the most ancient origin; *stone* engraving followed; and with the higher culture of society came *metal* engraving. The ancient Germans wrote (engraved) on wood and stone; from whence we have the Runic letters. We have many monuments of a very simple and uncultivated standard of the art executed by the ancients; and in the British Museum we have monuments from Nineveh and Egypt, which show the transition from *stone engraving* to *sculpture*. Consequently the art was known in most remote times.

Of *metal* engraving (which is the purpose of this address) we have many artistical works which show that the Egyptians, Greeks, and Romans had acquired great perfection in it. The British Museum, and the Louvre in Paris, contain a rich collection of metal engravings.

The Iliad and Odyssey of Homer (the two highest productions of the poetry of ancient Greece) are filled with descriptions of the decorations of the arms of their heroes, and the most conspicuous is the celebrated description of the Shield of Achilles. This proves that metal engraving had attained some perfection at that time. From this ancient style of engraving copper printing took its origin, about the 15th century. I believe Martin Schoen first engraved copper-plates for printing purposes. He was a goldsmith and painter, citizen of Kulmback, in Germany. He died in 1486. There are still prints existing which he engraved. It cannot be disputed that copper-plate engraving developed itself from form cutting; and probably the first prints were made by goldsmiths, who desired to retain the designs of their engravings.

From these introductory remarks upon the historical development of engraving, I proceed to that part of my subject more immediately connected with ourselves—namely, *watch engraving*, which is a branch of the art probably as old as watchmaking itself. There still exist many beautiful specimens of this kind of engraving which were executed about the commencement of the last century on so-called pocket watches; but at that time such works of art were highly expensive, and consequently rare. Watch engraving is now a somewhat important business, and is almost entirely confined to England and Switzerland, which countries supply the world with watches. When manufactures have attained a high degree of mechanical perfection, or have completely met the necessities of the public, the energy that brought them to that perfection must either stagnate or be continued in a higher direction,—that of *taste*; for there is a stage of cultivation when the mind revolts at the crudeness of mere utility, and it becomes a natural propensity to decorate or embellish whatever is useful or agreeable to us. But just as there are mechanical laws which regulate all our efforts in pure utility, so there are laws of the mind which must regulate those æsthetical efforts expressed in the attempt at decoration or ornamental design.

To enter at any length upon the question of the different styles of ornament is, I think, out of place here; and I will only touch upon this part of the subject so far as it is requisite for our purpose. Ornaments represent, to a certain degree, the vegetation of the countries from whence they took their origin; and the religion, character, and customs of the different nations which inhabited those countries have also contributed to give a character to the different existing styles. The original styles may be classed thus—the Ancient, the Mediæval, and the Modern; and each of these may be again divided into three classes—the *ancient*, into the Egyptian, the Greek, and the Roman; the *mediæval*, into the Byzantine, the Saracenic, and the Gothic; and the *modern*, into the Renaissance, the Cinquecento, and the Louis Quatorze. There are also many varieties of each of these original styles. The Egyptian style is very simple in its foundation, and in general has a symbolical meaning: for instance,—the lotus, or the water lily, represents the time of the inundations; and the zig-zag, the waves of the water. There are still many Egyptian ornaments very popular. In the Greek style there is a higher development of artistic taste, and ornaments are only used as decorations: the acanthus, the richest of the Greek ornaments (so well known to all artists), is a prominent feature in nearly all our decorations. The Roman style is a gorgeous imitation of the Greek, and its details are more elaborate. The Byzantine style, taking its origin from Christianity, applied all its decorations for symbolical purposes. The Saracenic style is nearly connected with the Byzantine; but the Mahometan religion not allowing the use of living animals and plants, scrolls covered with inscriptions from the Koran were introduced in general in the ornaments. The Gothic style, even more closely connected with the Byzantine than the Saracenic, consists essentially of pointed and geometrical forms, and its details are reproductions in miniature of its general outlines, based upon the Byzantine foundation. Those high rising monuments which

fill us with so much admiration, have probably borrowed their loftiness from the stately pine tree. The three modern styles, as the Renaisssance, Cinquecento, and Louis Quatorze, are a mixture of the ancient and mediæval styles. To attempt here to give a clear definition of them is out of the question, as their varieties are indefinite; yet I will remark that the Renaissance contains the greatest variety of the different ancient and mediæval styles, and is also the most extended.

Having thus given you a slight sketch of the reasons which may have produced the different styles of ornamental decoration, I shall leave this part of the subject. Decorating a watch is as much in accordance with our taste as any other kind of decoration, commencing with architectural structure and finishing with the ornamental seal of an envelope; and it is subject to as many changes as either—nay, even more, as nearly every country has its peculiar style for its fancy articles. In Switzerland the watch manufacturer decorates his watches according to the taste of the different nations he trades with. I will give you an idea of the different styles of decoration which are used there, as far as I can remember. It is not necessary for me to describe here the English style. For France the general style is a small bouquet, or a shield with a few flowers, with a very narrow border; the ground either strait barley or a fancy pattern of engine-turning. This is also the style for Italy. For Germany, heavy ornaments, with little engine-turning. The Russian taste is corresponding, intermixed with jewellery and enamelling. The Spaniard likes scriptural subjects, diversified with bull-fights. Turkey and the East most admire flowers, and the watch cases are in general decorated, both outside and inside with these ornaments. Naval subjects are the current taste of the North Americans, sometimes varied by gold-digging scenes. Mexico and South America have also saints and scriptural subjects, intermixed however with buffalo hunts and cock fights, as their standing decoration. Regarding China I am not able to give an idea, never having had an opportunity of seeing a decoration for that country.

Having shown that there exists a demand for decoration peculiar to every country where there is a watch trade, it follows that the manufacturer has only to tell the artist he requires a decoration to suit the taste of any particular country, and the artist acquainted with the different styles is able to execute them, the decoration being left entirely in his hands, except in some few instances. This gives rise to a competition among the artists to produce the newest and most beautiful designs. To enable them to do this, they are obliged to study drawing in all its various branches; and I think I am correct in stating that every master is compelled to send his apprentices to the drawing-school. There is a division of artists for the different branches of decoration, and very few excel in all. There are establishments solely occupied with dial-finishing, while others are employed only in decorating the watch cases. The decoration of domes forms also a separate employment. In Geneva, with very few exceptions, engine-turning and engraving are carried on in separate establishments; while in the mountains of Neufchatel these two branches of the business are in general carried on together. How far the artists of Switzerland have advanced in this branch of decoration is proved by the Reports of the three Great Exhibitions; and I believe the free competition which the manufacturers allow them is one of the chief causes of their advancement. Yet I must observe, these artists have an advantage over us on account of the flatness of their cases, which admits of the engravings showing with more effect.

We hear much spoken of the *cheapness* of engravings in Switzerland in comparison with those executed here, and also of the low wages given to the artists. For my part, I have not this opinion; for when I compare the prices paid during my sojourn there with those of the present time here, I find that for work for which a franc was paid in that country a shilling would be paid in this; and since that time I am informed higher prices have been given; and from my own experience I know there is about the same difference in the general expenses of living? How is it, then, that we hear always that the Swiss watches are more elegantly decorated than the English, and which is in reality the case? I believe the fault lies not with the English artist, but with his employer, who in most cases limits his skill to the execution of his own fancy, without considering that the artist has spent years in the cultivation of his taste. In all the other branches of engraving English artists are of as high standing as any of their continental competitors, and in some even far surpass them—for example, in medal engraving, and in armorial bearings. I have seen some works of art executed by Mr. Donalds, which display so much taste and skill that I think it is quite impossible to surpass them; and there are engravings by the late Mr. Habbel, which are worthy to be placed beside the works of the best artists of Switzerland; and, without doubt, there are many works of English artists deserving of the highest praise which I have not had the gratification of seeing. I must not here omit the just tribute due to the real artistical productions of Mr. Faucherre, who excels in the particular style of decoration he now executes. I believe I am justified in saying that all these artists of excellence enjoy full liberty to follow their own ideas; and this is the best explanation I can give why the generality of Swiss engravers have the advantage over us. If the English employers would allow their artists free scope for the execution of their own taste, after the manner of Switzerland, I believe we should very soon so far advance as not to be exposed to the humiliating remark, that *foreigners must be employed on artistical works.* Another great advantage for the Swiss artist is, that he receives his watches by at least half dozens at one time, and the cases of the different manufacturers are so equal in shape as to cause them no inconvenience in changing their designs according to the shape of the watches; and it cannot have escaped the eye of the manufacturer that sometimes he has seen a peculiar pattern on a watch case which has shown to great advantage, but the striking effect was lost when transferred to a case of a different shape. As much taste is required in selecting the patterns for the decoration of watches as skill in the execution of the designs; for, as Burke says, "It is known that the taste is improved exactly as we improve our judgment, by extending our knowledge, by a steady attention to our object, and by frequent exercises."

I trust, in the discussion following this address more light will be thrown on the subject than I have been able with my feeble efforts to accomplish. If I have failed in my endeavour to place a clear statement before you, do not attribute it to unwillingness, but to my imperfect knowledge of the English language.

A vote of thanks to Mr. Schweizer was moved by Mr. S. Jackson, and seconded by Mr. Klaftenberger, which was carried unanimously.

LE ROY'S PRIZE CHRONOMETER,

WITH A MEMOIR ON THE BEST METHOD OF MEASURING TIME AT SEA.

(*Continued from page 85.*)

PART IV.

Further observations on the Construction of the New Watch, by which we confirm the advantages of the methods which are used. —Difficulties in some of these methods removed.—Recapitulation, &c.

I propose, in this Fourth Part, to clear up some articles that I could not give with sufficient extent in the preceding without removing one object from another, which when brought together mutually render each other more intelligible.

One of those which most requires to be explained is the *motive force*.

This part of my watch, perhaps, may to some persons appear neglected. It has no fusee; nor have I used the methods which Messrs. Leibnitz,* Hook,† Huygens,‡ Sully,§ Harrison,‖ and others have applied, to render the magnitude of the vibrations, and the force which maintains them, constant. According to this method the watch has, we know, two motive forces; of which one, that only moves the last or the two last wheels, is wound up by the other, which being successively stopped or put at liberty by means of a detent, becomes foreign to the regulator.

I answer, that, supposing these methods to possess any advantage, nothing would prevent their application to my chronometer; they are known to men of science and artists, and the public have been in possession of them for a long time. I might have copied the gentlemen just now cited, if I had thought them necessary or even favourable for my machine; but various experiments, and the following reasons, have prevented me from making use of them.

1st. This method renders the machine more complicated, and of more difficult execution; it requires, besides the common constructions, a detent, a spring, a wheel or a fly, &c., whose adjustments are difficult. There are also few workmen capable of executing these in such a way as to be certain. They augment, says M. Le Roy, the friction; and the risks of stopping are greater in proportion to the number of pieces.

But if there are found so many inconveniences in remontoirs* applied to clocks, whose size is arbitrary, and besides are made to remain in a temperature that varies very little, on land, and in cities where we find workmen to repair them; what may not be objected against this practice in works whose size is confined, destined besides to receive continual motions, to be removed into all climates, to experience the extremes of different temperatures, and to be always either at sea, or in places destitute of skilful workmen?

With regard to the fusee, I only think it useful in watches where the vibrations of the regulator are not isochronous, and where it is necessary that the balance when stopped should be put in motion by the motive force. I think it would be superfluous, and even disadvantageous in mine, where the very powerful regulator makes its vibrations isochronous: in effect, it does not remedy the losses of elasticity of the mainspring, nor the clogging of the wheel-work. Besides, when the vibrations of my balance are so nearly equal in duration that they are isochronous, the fusee would not become the less useless if we wound up the machine at the same hour; which it would be easy to confine ourselves to. There would not even be a difference at all sensible in the arcs of vibration if we wound it up every twelve hours, and in the twenty-four hours the difference in the arcs actually amounts to but one-sixth. This fusee, whose inutility in my watch appears to me evident, would, besides, be disadvantageous. It would complicate the machine, and render it more subject to stop by the breaking of the chain; the watch would

* Journal de Savans, 1675.

† Ibid.

‡ Horologia Oscillatoria.

§ Description d'une Pendule Marine, Vol. 26, No. 103, Dec. 1806.

‖ Gazette du Commerce.

* It is usual, in clocks, to place a wheel underneath the barrel round which the cord is wound that sustains the weight. This barrel has the liberty of turning in a contrary direction to its usual motion in the clock. To the barrel is attached a ratchet and click, which prevents it from turning the way it is drawn by the weight, and of course the weight can therefore only descend by the motion of the whole train of wheels that give action to the clock. This contrivance is called a *remontoir* by the French artists. See Alexander, Traité Gen. des Horloges, p. 140.—T. S. E.

not go when winding up (an indispensable thing in a watch where two seconds is a considerable object) without having recourse to complicated methods, the greater part defective, especially in the present case, where nothing can be too simple for sailors.

The omission of the fusee gives likewise to my watch a very essential property, which it would have been deprived of by the methods of Messrs. Leibnitz, Sully, Harrison, &c. He who makes use of it is always by this means able to see whether the fundamental principle on which this kind of work ought to be constructed is found there;* —I mean the perfect isochronism of the long and short vibrations, which will be verified by observing the rate of the watch during the whole course of the spring.

Observation II.—*On the suspension wire.*—This wire is absolutely necessary to avoid friction, which, without it, would take place in the extremity of the lower pivot of the balance, and to preserve its freedom, on which, as has been demonstrated, depends all the regularity of the clock. An experiment, which I have repeated several times, suffices to show how essential it is that so powerful a balance, whose mass is so considerable, should be thus suspended. I took away the suspension wire, and I suffered the lower pivot to rest on a plate of tempered steel, well polished and thoroughly hard. Three days afterwards this plate was worn at the place of the pivots, the arc of vibration was considerably diminished, the freedom of the balance consequently very much altered, and the accuracy of the machine destroyed. I substituted for the steel plate a polished agate, and the same effect again took place. Lastly, to see whether when the weight of the balance was diminished on the agate the wear would not cease, I replaced the suspension wire. I attached its upper extremity to a lever, and I put a weight on the other arm of this lever, so that the balance, exceeding the weight a little, rested very gently on the plate of steel or the agate. Notwithstanding this precaution, the freedom was again very much altered by this slight friction; the plate and the agate both were worn, although much less than before; whence arose the inconveniences above mentioned. It appears, therefore, absolutely necessary in these kinds of works that the regulator should be suspended by a harpsichord wire, as the foliot was formerly by two threads of hemp or silk. In the first attempts which I made with this machine, nearly twelve years ago,* instead of using harpsichord wire to suspend it, I used a piece of thin narrow spring. Several experiments (by which I found that the different vibrations of a body thus suspended were much more isochronous than those procured to the same body by a spiral spring) induced me to make the regulating spring of my watch of this suspension spring, and to omit the spiral spring; but I soon perceived that, to approach isochronism nearly, it would be necessary that this regulating and suspending spring should be very long; this would render the machine very unwieldy in a ship. At last I arrived at the isochronism of the vibrations by combination and a certain proportion between the spiral (of which I found the long vibrations slower than the short) and the suspension spring, which gave me, on the contrary, the short vibrations slower than the long. This method, like the preceding, required a very long suspension spring; whence arose various inconveniences. It was at first difficult to be assured that the spring was sufficiently straight, and that the balance was attached in such a manner that its weight acted in a line along the middle of the breadth of the spring throughout its whole length; without this, however, it produced a very disadvantageous friction, and a difficulty in each vibration. Moreover, the weight of the balance was not sufficient to stretch this spring perfectly; it was hardly possible for it not to be bent a little in some part of its length: these curvatures diminishing by shocks and heat, or augmenting by cold, there arose irregularities difficult to prevent. Lastly, the distance at which the elastic force acted, being only equal to half the width of the spring, the least differences which might happen in the situation of this spring, whether by the small play of the balance in its holes, or by other causes, could not but have some influence on the manner in which it acted; this does not happen in the spiral spring, which acts always at a considerable distance from the axis of the balance.

All these inconveniences are prevented by the harpsichord wire. It is so small that it can have but little influence on the vibrations; it may be made much shorter; it is exactly stretched, and without curvature throughout its whole length; and, being round, we may be certain at first sight that all its parts agree with the axis of the balance. To this it may also be added, that, by the operation of drawing the wire, we are assured that the substance of which it is composed is homoge-

* To receive this advantage more completely, I leave the spring to open thoroughly, so that the watch goes 38 hours, but in common practice we stop the spring at about one turn.

* See the sealed paper which I left with the Secretary to the Academy in 1754, the Exposé Succinct, pages 40 and 42.

neous and pliant, such as it ought to be for this suspension. I have said it is necessary for the wire to be fine. Experience has proved to me that without this it would require to be very long, which would render the machine cumbersome. Having taken, to suspend a balance, a thicker harpsichord wire, of about four inches long, I remarked that the motion of the regulator lost with the greatest readiness until it was reduced to describe only four or five degrees, and then it remained as long a time in motion as if it had been either very long or very small; whence I concluded that the motion is not lost so readily in a large arc, that because the parts touched they formed an obstacle in some degree insurmountable, or experienced a considerable friction of the parts one against the other; whence it is evident that, a suspension spring being necessarily much more extensive in its width than a wire in its size, it can but be very long, and consequently very embarrassing.

Independently of the defects which we have before remarked in it, the necessity of using a very fine suspension wire (by having recourse to the means which I used to place this wire out of the way of accidents, to which its fineness exposes it) is therefore proved. (See Article VIII., Part III.)

OBSERVATION III.—*On the substance of the regulator.*—Steel appears to me preferable to construct the balance of; being a substance less dilatable, more solid, and less variable by the effect of heat, than brass, &c. The fears of magnetic influence are not, in my opinion, of any consequence. For them to have any foundation it would be necessary for this balance to acquire poles, which can never happen in a body that is continually changing its position; every effect which only increases its weight, or gives to its mass a tendency towards one side, would produce nothing in the vibrations, the balance only acting by its inertia.

OBSERVATION IV.—*On the motion of the balance.*—The friction on the pivots of the rollers which contain the balance of the new watch is almost nothing, for the following reason. The pivots of these rollers have necessarily a little play in their holes; whence it happens that, when these rollers describe a very small arc, their pivots only rest on the edges of their holes without rubbing. To receive the full advantage of this, and to have besides more freedom, a less resistance on the part of the air, &c., I have only rendered the arcs of vibration as great as the effect of shocks appeared to me requisite to be prevented. Each vibration of the balance is half a second, and the watch beats seconds; this appeared to me the most convenient and the most advantageous. I could not have increased the number of vibrations in a given time without increasing the operations of the escapement also, and without the freedom of the balance suffering some diminution.

OBSERVATION V.—*On the compensation for the effects of heat and cold.*—According to the Gazette du Commerce, and the report signed Ludlam, sent to the Academy, to remedy the irregularities produced in marine watches by heat and cold, Mr. Harrison uses a bar composed of two thin pieces of brass* and steel, two inches in length, riveted together in several places, fixed at one end, and having at the other two pins across, through which passes the balance spring. If this bar remains straight in temperate heats, as brass receives more impression from heat than steel, the side where the brass is becomes convex by heat, and the steel side becomes so by cold. Thus the pins, one after another, fix the parts of the spring according to the different degrees of heat, and lengthen or shorten it; whence follows the compensation for the effects of heat and cold.

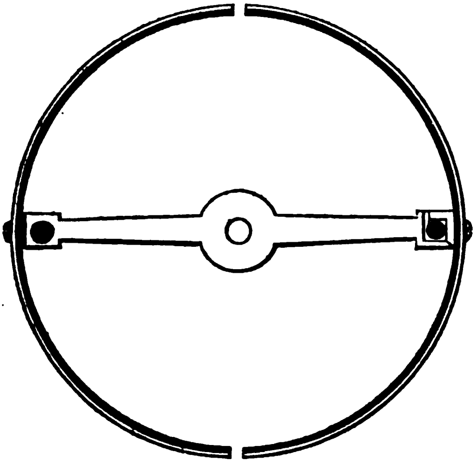
If I had known this ingenious method before I thought of my thermometer, probably I should not have hesitated to have made use of it in my machine.

I considered some time whether I should not give it the preference. I even made some attempts with this view. I shall speak of them presently; but, after having thought of them seriously, and after having put aside, as much as I could, that prejudice which we have in favour of our own productions, my thermometer appeared to me preferable. The following are the reasons which induced me to judge so.

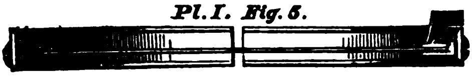
The first, which would have prevented me from making use of it without some considerable change, was, that by Mr. Harrison's method the regulating spring does not remain always of the same length, which I have proved (Article III., Part V.) to be absolutely necessary. Likewise, when I endeavoured to compensate the effect of heat and cold by pieces of brass and steel riveted together as Mr. Harrison's, I endeavoured not to change the length of the spiral, but to make a considerable part of the circumference approach or recede by this means from the centre of the balance. For this purpose I used a

* The author makes use of the word *cuivre*, which is commonly used to express copper; but in Mr. Harrison's pamphlet it is *brass*; we have therefore given it so. From this it appears probable that the author in other places may mean brass, although that is commonly distinguished from copper by *cuivre jaune*. —T. S. E.

Plate I., fig. 4.



Pl. I. Fig. 5.



balance (*figs.* 4 and 5, Plate I.) composed of two semicircles, each formed of a piece of brass and steel united as in Mr. Harrison's thermometer piece.

(*To be continued.*)

FUSEE *versus* GOING-BARREL.

To the Editor of the Horological Journal.

Sir,—As a member of the British Horological Institute, I trust you will not consider a few remarks from me on the subject of going-barrel watches out of place. I was surprised, on perusing the report of the Third Discussion Meeting, that a subject of such general importance should be treated in so superficial a manner; and I consider that Mr. Jackson's proposition to adjourn the meeting ought to have been accepted, as it would then have given other members an opportunity of stating their opinions.

As far as the report goes, there is really no argument either for or against the introduction of the going-barrel in English watches. That Mr. Bennett is in possession of a going-barrel watch which loses only 15 seconds weekly under the circumstances mentioned by him, proves nothing as far as principle is concerned; and as little to the purpose are Mr. Jones's remarks on the six going-barrel watches, as well as Mr. Jackson's assertion that the three eight-day clocks which he made lost from 100 to 125 seconds daily during the last days. These gentlemen attribute the inaccuracy to the motive power, when, in reality, the regulating power was in fault;—and if these time-keepers had had fusees, the same fault would have still existed, and a variation even to a greater degree would have taken place as soon as the oil had lost its fluidity. The fusee, in both cases, would only have been the means of hiding an error in the pendulum spring for a short time, but not of removing it. Did it never strike these gentlemen that their pendulum springs caused accelerated motion in the long arcs of vibration, and *vice versa;* or, in other words, that they were too short?

If I am not trespassing too much on your limited space, I will now give you my opinion of the principal faults in barrel watches, and to which may be attributed the reason why this principle has not yet been applied to lever escapements with any degree of success either as regards performance or economy; and I think that if the subject be given due consideration, there is not the slightest doubt but that such alterations could be made in the calibre at present in use as would make it at once easy of construction, and to a much greater degree correct in performance; although I am perfectly of Mr. Coles's opinion that such a thing as an adjustment cannot be got out of a wheel-barrel mainspring, notwithstanding the idea to the contrary be supported by such high authority as M. Robert, of Paris, from whom Mr. Bennett takes his reasoning.*

Going-barrel watches are made of two distinct calibres. In one, the barrel is supported on the plate with the centre wheel under the barrel; in the other, the barrel is supported by a bridge, with the centre wheel over the barrel. Both have faults. In the first-mentioned the barrel can only be one-half the height of the whole movement, and leaves a very short wind-up square, but on the other hand it has this advantage, that the whole height of the movement can be used for the escapement. In the latter, a much greater amount of spring power can be obtained, as the barrel can be four-fifths of the whole height of the movement; but although this calibre possesses so great an advantage, the centre wheel occupying part of the height required for the escapement renders it almost unfit for the lever,—the escape-wheel pinion

* Although Mr. Bennett quotes M. Robert as an authority for obtaining an adjustment out of wheel barrels, he does not seem to be aware that it is by different means to any which he brought forward at the Discussion Meeting. In M. R.'s method the outer turn of the spring must be free from the wall of the barrel when it is at rest; consequently the spring must be very short, the arbor small, and a great number of turns are unused. See M. Robert's article in "*La Science,*" 6th Dec. 1855, Paris; also, later, in the "*Revue Chronométrique.*"

and lever staff being so inconveniently short, and the balance space so small, that it requires a workman of no ordinary capabilities to escape this calibre; and if the centre wheel be of the proper proportion, the pendulum spring cannot be of sufficient diameter to ensure an easy and correct adjustment. The Swiss manufacturers (as did also the British Watchmakers' Company, formed some years since in Dean-street, Soho), to avoid being so cramped in height, make use of the unproportionate long lever, in order to pitch the lever and escape pinion pivot holes outside the diameter of the balance; the evil effect of which, combined with that of insufficient room for the pendulum spring, has led to the belief that levers with going-barrels cannot be brought to that degree of perfection to which the Swiss produce horizontal escapement watches.

In conclusion, my belief is, that the principle of the going-barrel can be made as applicable to lever as to horizontal escapements,—that the calibre, and not the principle, is in fault; and that if the subject be given due consideration, the existing errors rectified, and an universal measurement adopted, Clerkenwell will produce lever watches as cheap as and undoubtedly far superior to those of any foreign country.

SIEBE.

PENDULUM SPRINGS.

[The following communication has been received from Mr. Hammersley in continuation of his former letter on Pendulum Springs.]

Sir,—I have placed in the Museum of the British Horological Institute some *double flat* isometrical balance springs for watches, which will secure all the advantages of the cylindrical spring without increasing the thickness of the watch, which cannot be avoided in the use of cylindrical springs. With this improved spring I can guarantee a lever watch to gain sufficiently in the short vibrations to compensate for the natural tendency to lose from the thickening of oil and change of position, so that a lever watch may be made to keep to a nearly uniform rate.

Some may have doubts on this point; but, after considerable experience in adjusting lever and duplex watches, I can confidently affirm that this spring will answer every requirement, as regards time, without a regulator. And I expect by this improvement to have more control over the long and short vibrations than with any other spring which has yet been made.

Watches that are properly made, with a flat spring, if a few things be attended to which I shall mention hereafter, might always be sprung without a regulator, as I have always found that in watches that I have adjusted and made the escapements myself, I have been able to keep them under control by the timeing screws alone.

One lever watch, which I had adjusted with a flat spring, without a regulator, was sent out with a gaining rate of one second per day. At the end of two years it was brought back to be cleaned, and was still gaining. This occurred twice, and in both instances it was six minutes fast, and at no period during that time had it been more, though it had never been regulated.

I have found by close observation that half a turn of the timeing screws is quite sufficient to regulate all the lever watches that I have sprung either with or without regulators.

J. HAMMERSLEY.

Bedford View, Bristol.

ON THE PREPARATION OF OIL FOR HOROLOGICAL PURPOSES.

To the Editor of the Horological Journal.

Sir,—In the years 1814 and 1815 I was in the Arctic regions, and I remarked that train oil stood more cold than any other, and that a portion of it never congealed. This was the *oleine*, which we preserved and applied to our chronometers, and thus kept them performing through the Arctic winter. To procure a stock to bring away, not having sufficient blubber to extract the oleine by exposing it to the frost, we took in the summer more blubber from a fresh-slain whale, melted it down slowly with a handful of garlic in the kettle with it; then again boiled it with garlic, which took away the fishy smell, and washed it repeatedly with distilled water to free it from salt. We then to sixteen ounces of oil added twenty ounces of distilled water, and sixteen grains of *subcarbonate* of potash, shaking the vessel several times for a few days; then poured it into other glass vessels, letting it stand exposed to the light for fourteen days, and after this skimmed the oleine off the top.

This oil did not congeal during the winters. We also prepared oil by manipulating precisely in the same manner except using the potash. Instead thereof we separated the stearine from the oleine by adding to the oil absolute alcohol, shaking all together in a vessel, and placing that vessel in a copper filled with

water, and heating it to within ten degrees of spirit boiling; after this, poured the contents into a shallow vessel, and placing it over the copper of boiling water drove off the spirit by evaporation, and then drew lines or furrows through the whole thickness of the fatty matter contained in the shallow vessel; after the spirit evaporated, turning the vessel up at an inclined angle of 60 or 80 degrees, the pure oleine slowly drains off into a receiver placed for the purpose. This oil is very expensive, as you will get but a small quantity of oleine, but it will endure as much cold as brandy, and is incorrosive. I ought to have stated that in making the last-named oil, we neutralized the acid by keeping shavings of lead in it for six months, and then decanting it off.

Another method we resorted to with olive oil, when it was solidified by cold. We cut slices from the mass, and pressed them between several folds of bibulous paper placed between slabs of stone to keep them cold; when the paper became saturated with the oleine, we removed it into water, and there squeezing out the oil, it floated on the top and was skimmed off. The acid was neutralized by lead scrapings, and manipulated with the alcohol, as in the process of the former oil. This oil is also incorrosive, and will endure twenty degrees of cold without congealing. There is no necessity for the use of alcohol in making this oil for general purposes; but if for use in the Arctic regions it may be necessary, inasmuch as a small portion of fatty matter will be separated by the alcoholic process. This oil may at any time be procured by exposure to artificial freezing.

Kingston on Thames,
13th January, 1860. S. Long.

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

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(*Continued from page 87.*)

1818, January 29.—No. 4214.

PRIOR, George.—The invention consists of an additional wheel, and other apparatus. Its axis is connected and concentric with the pivot of the escape wheel, and the two wheels have the same number of teeth. Round the axis is coiled a spiral or helical spring, one end of which is attached to the axis, and the other to the renovator which is screwed on the pivot of the escape wheel. When this pivot is turned by the main spring, the renovator winds up the spiral spring, until one of the teeth of the escape wheel is stopped by the detent. When the balance is set in motion, the additional wheel, whose teeth impel the balance, being unlocked, removes a lifting piece which is connected with the detent of the escape wheel, and allows this to proceed forward another tooth, and the renovator winds up the spiral spring as before.

[Printed, 5*d*. See Repertory of Arts, vol. 34 (*second series*), p. 1; and Rolls Chapel Reports, 8th Report, p. 124.]

1818, December 5.—No. 4317.

SEYFFERT, Frederick William.—New arrangement and construction of the repeating motion, by which, the inventor says, "I am not only enabled to "reduce the repeating motion, as heretofore used, to "more simplicity by saving the crinnelier creinaillier "with its chain and varrels and hour snail (limason), "but the rest of the work can be done with less "trouble, and of course less expence. My invention "is applicable to repeating watches and repeating "clocks, with or without running wheels, and to clocks "and clock watches."

[Printed, 8*d*. See Rolls Chapel Reports, 8th Report, p. 128.

1820, May 19.—No. 4465.

MASSEY, Edward.—"Improvements in the con"struction of chronometers and pocket watches."

[No Specification enrolled.]

1820, October 20.—No. 4501.

PREST, Thomas.—A brass wheel whose teeth have a double action, vertically and laterally, is moved by turning a pendant knob, and thus gives motion to a wheel fixed upon the square of the barrel arbor, thereby winding up the main spring.

[Printed, 5*d*. See London Journal (*Newton's*) vol. 2, p. 173.]

1821, January 27.—No. 4530.

COLE, James Ferguson.—The escapement is detached, the improvements consisting in the application of a safety pin to a detent with pivots, a locking plate to the balance axis, and the return or unlocking spring in a reversed position. The balance is in form a circular plate, flat on one side, and turned hollow on the opposite side to such a depth as will leave no more substance or thickness than is sufficient to firmly support the rim. The effect of heat and cold on this chronometer is compensated by a curb, which curb is actuated by a compensator, the motion of which in one direction increases and in the contrary direction diminishes the acting length of the balance spring.

The aforesaid curb and compensator are so connected with the balance cock and the apparatus for adjustment, that by turning with a key a tangent screw, the time-regulating piece, compensator, curbs, index, and other parts thereunto affixed, will be set in motion, and the acting length of the balance spring thereby varied.

[Printed, 7*d*. See London Journal (*Newton's*), vol. 4, p. 63.]

1821, January 27.—No. 4531.

ARNOLD, JOHN ROGER.—Expansion balance, consists of a straight expansion piece vibrating about its own centre, the upper part being of brass, and melted on the lower part, which is steel. A weight is screwed on to each end; and these weights, being screwed nearer to or farther from the centre, will alter the mean time, and cause the vibrations to be faster or slower. Two steel arms hang down at right angles from the straight piece, at equal distances from the centre, and at the extremities of these are also screwed weights. If the balance gains in heat and loses in cold, the weights must be screwed upwards; if the contrary, downwards; or, if necessary, the weights must be reduced and increased respectively.

[Printed, 5*d.* See London Journal (*Newton's*), vol. 2, p. 173.]

1822, February 9.—No. 4645.

FATTON, FREDERICK LOUIS.—An astronomical instrument. On the face of the instrument are three dials; one of which revolves, completing a revolution every minute, and is divided into periods of 5 seconds each; the other two are fixed, and their hands are made to go round, one in every 10 minutes, and one in every 5 hours respectively. Inside the instrument is a plate, one end of which is moveable on an axis, and at the other end is placed a standard, to which is an arm, and at the extremity of this arm is a little thing like the nib of a pen, which contains a little ink or other colour, or holds a pencil. This arm is so raised by the said standard as to be above the revolving dial. By pressing a button on the outside, certain machinery consisting of lever, star-wheel, springs, &c., is worked upon so as to cause the said nib to descend, and by an instantaneous motion to strike the revolving dial and leave a mark or dot thereon. The machinery is immediately ready to perform another operation of the same sort.

On the axis of the wheel which turns the 10 minutes hand is a snail, which, as the wheel revolves, pushes the end of the said plate which carries the arm, so as to cause the nib to approach nearer and nearer to the centre of the revolving dial, as the 10 minutes hand accomplishes its revolution. By this means, although the revolving dial goes round once in a minute, it will show the marks or dots without confusion during 10 minutes At the commencement of every 10 minutes, the nib is made just to overhang the circumference of the revolving dial, and at the expiration of the 10 minutes, the snail having been carried once round, the nib returns to the same place again. The instrument requires winding up every 5 hours.

[Printed, 8*d.* See Repertory of Arts, vol. 1 (*third series*), p. 1; and London Journal (*Newton's*), vol. 4, p. 296.]

(*To be continued.*)

EQUATION OF TIME TABLE
For MARCH, 1860.

Day of the Week	Day of Mnth	At Apparent Noon — Equation of Time to be *added* to Apparent Time.	Difference for One Hour.	At Mean Noon — Equation of Time be *subtracted* from Mean Time.
		m s	s.	m. s
Thurs.	1	12 29·53	0.519	12 29·64
Fri. ..	2	12 17·08	0·540	12 17·19
Sat. ..	3	12 4·14	0·559	12 4·25
Sun. ..	4	11 50·72	0·578	11 50·83
Mon. ..	5	11 36·84	0·596	11 36·25
Tues..	6	11 22·54	0·613	11 22·65
Wed..	7	11 7·82	0·629	11 7·94
Thurs.	8	10 52·72	0·644	10 52·84
Fri. ..	9	10 37·26	0·658	10 37·38
Sat. ..	10	10 21·46	0·671	10 21·58
Sun. ..	11	10 5·35	0·683	10 5·46
Mon. ..	12	9 48·95	0·695	9 49·06
Tues..	13	9 32·27	0·706	9 32·38
Wed ..	14	9 15·33	0·715	9 15·44
Thurs.	15	8 58·18	0·723	8 58·29
Fri. ..	16	8 40·82	0·731	8 40·93
Sat. ..	17	8 23·27	0·738	8 23·37
Sun. ..	18	8 5·55	0·744	8 5·65
Mon...	19	7 47·68	0·750	7 47·78
Tues..	20	7 29·68	0 755	7 29·77
Wed ..	21	7 11·57	0·759	7 11·66
Thurs.	22	6 53·36	0·762	6 53·45
Fri....	23	6 35·06	0·765	6 35·14
Sat. ..	24	6 16·70	0·767	6 16·78
Sun. ..	25	5 58·30	0·768	5 58·38
Mon...	26	5 39·86	0·768	5 39·93
Tues..	27	5 21·41	0·768	5 21·48
Wed ..	28	5 2·97	0·767	5 3·03
Thurs.	29	4 44·54	0·766	4 44·60
Fri....	30	4 26·16	0·763	4 26·22
Sat. ..	31	4 7·85	0·760	4 7·90

TO CORRESPONDENTS, &c.

*** Anonymous Communications cannot be attended to.

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EXPOSITION DE BESANÇON EN 1860.

THE Council of the British Horological Institute give notice, that a GENERAL EXHIBITION of CLOCKS, WATCHES, JEWELLERY, and GOLDSMITHS' WORK will be opened at Besançon on the 1st of June, 1860, under the patronage of H.I.H. Prince NAPOLEON.

The object of the Exhibition is to prove the rapid progress, and excellent quality of the French Watches, and to invite Foreign Makers to exhibit their Work, and in a peaceful rivalry to evidence the progress made by all nations towards perfection.

The SOCIETY OF EMULATION, of Doubs, have forwarded to the Institute their Report, and a Programme of their proceedings, giving every information to intending Exhibitors; a Translation of which, as well as the original, can be seen at the Institute during Office hours, from 2 till 8 o'clock.

Extract from General Rules.

" ART. 6.—Exhibitors should address the Secretary of the Exhibition before the 1st of March, 1860, indicating—

" 1. The name, Christian name, profession, and residence of the Exhibitor;

" 2. The nature, number, and quantity of things to be sent;

" 3. The space required—height, depth, and width.

On the advice of competent judges, the Executive Committee will decide on the advantages of the Sender.

" ART. 7.—The Committee will bear the expense (going and returning) of things named in Special Letters.

" ART. 11.—Products, French or Foreign, are to be addressed to the President of the General Commission. They must be received between the 1st of April and 1st of May, 1860.

" ART. 13.—Every thing sent should be accompanied by an Advice, recapitulating the points in Art. 6, with the Signature of the Sender.

" ART. 14.—The Committee will receive Productions from abroad, but will not be answerable for the Duties.

" *Subjoined to General Rules, and applicable to all kinds of Productions.*

" 1.—Products sent must be conveyed by the ordinary conveyances, or by Express.

" 2.—The Committee do not bind themselves to place all the Articles sent.

" 3.—The Committee are not answerable for accidents, &c."

" The Articles sent cannot (unless under circumstances very peculiar, and on the merits of which the Committee shall decide) be removed till the end of the Exhibition.

" Pictures, Objects of Art, Industrial Produce, shall be bought according to the will of the Committee, and put in lottery with the objects which shall be left as Gifts by the Exhibitors.

" At the end of the Exhibition, Medals and Honorary Mention shall be decreed, on the authority of a Special Jury, to the Works and Productions considered as the most remarkable."

The following Communication has been received from the Mayor, President of the Committee of the Exhibition at Besançon.

(Translation.) " HOTEL DE BESANÇON, *February*, 1860.

" *To the President of the British Horological Institute.*

" SIR,—I have the honour to acknowledge the receipt of your letter of the 7th of February, also of the Number of the Journal in which the Council of the Institute has announced the General Exhibition of Clocks and Watches at Besançon.

" I hasten, Sir, to thank you for your obliging mediation with the Council of the Institute, and to beg that Honourable Company to continue a course which cannot but have the happiest influence on the success of our Exhibition.

" Will you, Sir, assure the principal Chronometer, Watch, and Clock makers of Great Britain of the excellent reception that their remarkable productions will find in our Palace of Exhibition, and of the lively desire which animates us to render them a brilliant homage before all the Clockmakers of the world.

" I address the same to all the Members of the Council, of which your Journal has furnished the names. I also send you a certain number of our Programmes and Circulars, which I beg of you to distribute in the manner which appears to you to be the most to our advantage.

" Will you, Sir, accept the assurance of our high respect. " C. CONVERS."

THE BRITISH HOROLOGICAL INSTITUTE.

We have great pleasure in announcing, on the part of the Council of the British Horological Institute, that the Lecture on Mineralogy with especial reference to the Minerals used in Watch-Jewelling, so kindly promised by Professor TENNANT, F.G.S., of King's College, will be delivered by him at the Amwell-street School-rooms, on Tuesday the 17th instant, at Half-past Eight o'clock in the Evening.

CLASSES FOR INSTRUCTION IN GEOMETRY AND DRAWING.—The Council, as announced in our last number, have made arrangements with a highly qualified Master to give Instruction in Geometry, and in Mechanical and Ornamental Drawing as applicable to Horology, to such Members of the Institute as may be desirous of availing themselves of this means of improvement.

Lessons will be given, at the Rooms of the Institute, in Geometry once a week, and in Drawing twice a week, as soon as the names of Twelve Pupils shall have been received.

The Fee will be 5*s.* per quarter for the Geometry Class, and 7*s.* per quarter for Mechanical and Ornamental Drawing, or 10*s.* per quarter for Pupils joining both Classes; the fee, payable in each case in advance, includes all Drawing instruments and materials except a board and T square.

The Drawing Master's Pupils Specimens of Mechanical and Ornamental Drawing may be seen by application at the Institute.

Special Notice to the Trade.—The Council specially and respectfully urge upon Parents and Employers the great importance of allowing those under their care an opportunity of attending these Classes, which are offered on terms of great advantage, and which by adding sound theoretical knowledge to practical qualification must benefit them by enlarging their understanding of mechanical principles.

The receipt of a few more names is alone wanting to commence the course.

All particulars as to membership may be obtained on application at the Institute.

By order of the Council.

Members of the Institute, and the Trade at large, are again earnestly requested to lend their co-operation in the promotion of Horological science by the reading of Papers or the delivery of Lectures on any subject connected with Chronometer, Watch, or Clock-making with which they may be specially acquainted; it being considered that information upon any branch of Horological manufacture must be interesting to the Members generally. Persons so disposed are requested to forward their intentions addressed to the Secretary at the Institute.

ANNUAL DINNER OF THE BRITISH HOROLOGICAL INSTITUTE.

The Second Annual Festival of the Members and Friends of the Institute was held at the Freemasons' Tavern on the 29th February, when about 150 gentlemen were present.

In the absence of VALENTINE KNIGHT, Esq., J.P., and President of the Institute, through illness, the chair was occupied by Mr. JAMES STODDART, one of the Vice-Presidents; who was supported by Mr. James Adams and Mr. E. J. Thompson, Trustees of the Institute; Professor Tennant, of King's College; Mr. Carley, Mr. W. Rowlands, Mr. J. F. Cole, one of the Vice-Presidents; Mr. R. R. Hux, Treasurer, and the following members of the Council: — Messrs. J. S. Adams, S. A. Brooks, D. Clarke, W. B. Crisp, T. Gordon, C. Gartner, C. Guillaume, C. J. Klaftenberger, T. Leonard, G. E. Mylne, C. March, J. Murray, F. Potter, J. Roberts, R. Schweizer, J. Shepherd, T. Swift, E. Storer, J. Trewinnard, J. F. Watson, F. R. Warman, and L. J. Webber. There were present also Mr. John Jones, Mr. E. D. Johnson, Mr. F. S. Notermann, and other eminent horologists; with Mr. W. S. Wilson, Mr. Leonard Collmann, Mr. J. Brown, F.R.C.S., Mr. J. Hobbs, Mr. D. Rivolta, Mr. C. Rowlands, Herr Derffel, Mr. J. Faucherre, Mr. Dennis Macdonell, and many other visitors.

The vocal arrangements were conducted by the celebrated artistes, Mr. Lawler, Mr. Donald King, and Mr. Dawson, whose exertions during the evening gave great satisfaction.

The CHAIRMAN, at the conclusion of the dinner, read the following letter received by him from Mr. Valentine Knight:—

"3, Cornwall-terrace, Regent's-park,
Feb. 28th, 1860.

"MY DEAR SIR,—I deeply regret my inability to preside at the dinner to-morrow at the Freemasons' Hall. I have been confined to my room the last few days with a violent cold, indulging in the hope daily of my being convalescent by Wednesday; but I am now compelled to say I am really unequal to the duty, or be assured I should not be absent.

"With my best wishes for the success of our Institute,

"Believe me your's sincerely,
"G. E. Mylne, Esq." "V. KNIGHT.

The CHAIRMAN gave the usual loyal and national toasts, which were warmly responded to.

The CHAIRMAN next gave "The Science of Horology," coupling with the toast the name of Mr. J. F. Cole.

Mr. COLE, in responding, said he understood by the science of horology, mathematics in all those branches which could in any way be brought to bear upon the art of watch and clock making. Instruction in these branches of mathematics was of primary importance, and he was glad to see, by the formation of classes and other things, that the Council of the Institute were impressed with this fact. He was convinced that the successful issue of their endeavours would result quite as much to the good of the public as to the good of the trade. The effect must be, that they would be enabled to produce watches of a superior quality, at reduced prices. He knew there were many, even in the trade, who, if properly encouraged and provided with needful appliances, could pursue the objects of the Institute to such a successful issue, that they would have nothing to fear from foreign competition. Much depended on the accuracy of their knowledge and practice of mechanical principles. For himself, he had given 40 years of unremitting exertion to the study of the science, often sacrificing a whole night's repose, and never taking a single week's relaxation, and he did feel satisfied at having arrived at certain principles, and rejoiced at every opportunity of getting them carried out. But it was little that a private individual could do to give general currency and gain general adoption for any such principles, especially among the higher branches of the science. He had had great support, but still an inadequate degree of support, and many of his views were still in abeyance for the want of the propelling power It was not possible for him in these few observations to convey what he meant, but he hoped they would be sufficient to inspire something like a feeling of sympathy for his aims. It was a common argument, that if they interfered at all with the manufacture, it would only have the effect of stopping the progress which under present circumstances was being made. He did not believe this. He felt certain that the encouragement of reform — and a wholesale reformation was needed — would result most decidedly for the good of the trade. Mr. Cole proceeded to enforce this assertion by a reference to his own experience ever since—40 years ago—the admirable mechanisms of M. Breguet, of Paris, set him thinking and contriving, and that with success, to equal them in beauty and accuracy. Mr. Cole sat down amid loud cheers.

The CHAIRMAN said that the next toast he had to propose was naturally connected with the last he had given — in fact, they might have been amalgamated in one—"The British Horological Institute." The doctrine, to a certain extent, they had heard; the practical part had to be referred to. The Institute had existed about two

years. The energies of many gentlemen had been exerted in bringing it into existence. What did the Council propose to themselves as the results of its working? The large company present showed the strong interest felt in its existence, and there must be a conviction in the minds of most of the gentlemen present that good must result from it. What the Institute had hitherto done was to procure Lectures to be given by properly qualified men upon the parts and construction of watch and chronometer work. There had also been Discussions, which, perhaps, might not come up to the mark of an assembly where all were perfect in elocution, logic, and rhetoric; but which, as far as he had seen, had certainly tended to the benefit of the members, to the imparting of knowledge, and to the stimulation of the mental powers of the mechanics engaged in the trade. There was, further, a Library and a Reading-room, although watchmakers, whose eyes were tired during the day, might not at present have been induced to avail themselves of the advantages of the latter to the extent they might have done. It was proposed to form classes for the study of geometry, and for mechanical and ornamental drawing, which would be opened and taught by competent teachers when the names of a sufficient number of pupils have been enrolled. The Council had been active; and, looking at the varied objects of the Institute, he thought it had achieved as much as could be expected of it. All honour was due to those who had originated the Institute; their names would not be forgotten.

The toast was drank with great applause.

The Chairman said that they had some distinguished visitors present, one of whom was Professor Tennant, the Professor of Mineralogy of King's College. Having alluded to horology as a science, it would not be out of place to connect his health with the toast which had just been drank.

The health of the learned gentleman was drank with applause.

Professor Tennant was not accustomed to appear before such large audiences, and was not prepared to address a company of such a description. The science of mineralogy, to which reference had been made, belonged to a department of considerable interest, and probably to no men more so than to the practical jeweller. They had in the mineral kingdom upwards of 500 simple minerals, about ten of which were of great importance to the company present in their profession. If he took up a watch, he found the glass composed of mineral matter—silica. The case, whether simple silver or gold, or a mixture of metals, was again derived from the mineral kingdom. The works were obtained from the same source, and the mainspring likewise. The jewel belonged to the same class. To persons employed in such a manufacture, a knowledge of the principles of the mineral kingdom would be of the first importance, which might be gained in a short time; and if they would do him the honour to come to him, or if the Council of the Institute would allow him to address their young men upon the subject at their own place of meeting, he should have great pleasure in giving them a lecture on the first principles of the science of mineralogy as applicable to horology. He was specially at home in addressing young men, who were training for any profession, on the first principles of the science, whether they were military students or others. On the morrow he would have an auditory of about sixty-five military officers, young men seeking for commissions, and who would be appointed in the course of a few months. That was a most important part of his business. He would go with them to the British Museum to look through its geological department. He was obliged to leave that festive board to go to the Society of Arts, where an important paper was to be read upon the subject of building stones. There was no city in the world where worse materials were used for that purpose than in this metropolis; the paper, therefore, was of great importance, and he was anxious to say a few words upon it. Such instruction in the elements of the science of mineralogy he knew to be very necessary; for he found persons engaged in their manufacture incapable, for example, of distinguishing one kind of ruby from another. If he were to ask them the difference between an oriental ruby and a spinel ruby, they could not tell; and the same with other stones upon which they were working. He recollected a most remarkable case of error of that description, where a person supposed that he had a stone of great value, and which was estimated at the modest sum of £21,000. It had frequently been shown to him (Professor T.) by the owner; but when brought to him after the decease of its possessor, an eminent jeweller in the City, by his widow, he having examined it, told her to take it to an institute and ask the sum of ten guineas for it. Let them only conceive the mortification of that lady upon finding that, instead of £21,000, ten guineas was the utmost value of the stone upon which her husband had set such a price. That was one case out of many, showing that many persons engaged in commercial transactions in precious stones were in the habit of making the mistake of substituting one substance for another. In walking through the public thoroughfares they found jewels marked up in respectable shop windows at monstrous prices. If the sellers of such articles were unacquainted with their nature and value, what, in all probability, were the means of knowledge of the purchasers of them? They absolutely misnamed the articles, and called one for another. The devotion of an hour, therefore, some evening, whether in the course of a month or a few months, in their lecture room, to the consideration of the first principles of mineralogy, would be most useful, and he should be very happy to place his services at the disposal of the Council for such a purpose.

The Chairman said that he had a toast to propose which, at all events, would create some little enthusiasm, and meet with a hearty response. He knew of no case where men's feelings were more wrought upon than when a gentleman, universally respected, had promised to attend and preside over such a meeting as that, but found himself unable to do so. Such had been the case with their esteemed friend Mr. Valentine Knight, whose better health he had to propose. (Loud cheers.) He had already been a great benefactor to the Institute, to which he had that night sent his

third subscription of ten guineas. That was a substantial proof of his attachment to it. From its first establishment that gentleman had manifested a warm interest in the undertaking. Having retired from business for a number of years, he was entitled to double credit for allowing his mind to revert to Clerkenwell, and to feel such a deep interest in the prosperity of the members of the trade with which he was formerly connected. The fact showed that his heart was in the right place. He (the Chairman) had known Mr. Knight many years—thirty at least—and had ever been treated with kindness by him. Although he was growing old, he was the same man he ever was.

The toast was drank with the greatest enthusiasm.

The Chairman then rose to propose the health of gentlemen whose office formed a necessary adjunct of the Institute. Whilst property was in existence it was necessary that somebody should be put in trust thereof. In an Institute which consisted of some 300 members, it was essential that gentlemen should be appointed for that purpose in whom the members could have confidence that their property would be safe in their hands. Three such gentlemen had been elected for that purpose —Mr. Valentine Knight, Mr. James Adams, and Mr. E. J. Thompson.

The health of those gentlemen as Trustees was drank with all the honours.

Mr. James Adams, in responding on behalf of himself and colleagues, regretted the absence of Mr. Valentine Knight. He looked forward to the day when the Trustees of that Institute would be the holders of a very important property. He was not prepared to say when, but he hoped that the time was not far distant when the Institute would take that position which he really believed it ought to occupy. He congratulated the Chairman upon the large company present, which might indeed be regarded as a proof of the prosperity which the Institute might expect in future. The members had most materially increased since the last annual dinner, which showed the great interest felt in the Institute by those who were connected with the art of horology, which he hoped would some day take its proper position in the country. He was afraid it had not been hitherto as much respected as it deserved to be. The watch and clock makers of England had been looked upon, he was sorry to say with some good reason, as mere thumb workers. He did not himself profess to be a very scientific manufacturer; but he knew several workmen who, if they had had an opportunity in their younger days of availing themselves of the advantages of such a society, would have held a much higher position than they occupied at present. The Institute had been formed for the improvement of the younger branches of the trade, and he was happy to say it had hitherto been very successful. He had been particularly struck with the observations made by Professor Tennant, which proved how willing gentlemen of high scientific attainments were to assist institutions designed for the elevation of their younger members. Education was making rapid progress. Those who lived to see the next generation would find in the market a very different class of watches to those which were to be met with now. It gave him much pleasure to be present on that occasion. He was pleased to see so many friends joining the Institute; and he trusted that, with their assistance, it would soon fill that important position its merits entitled it to occupy in this country.

Herr Derffel, a celebrated German musician, then played a solo on the pianoforte with the most exquisite taste and the greatest brilliancy of execution, and which elicited the heartiest encore we have heard for a long period.

Mr. Carley said that they had drank the health of Mr. Knight, their President, who deserved all the honour they could pay him; but presidences were very honorary offices, whereas Vice-presidents were called on to do a great portion of the work of institutions, and he (Mr. C.) therefore proposed the health of those gentlemen. They had given very close attention to the concerns of the Institute, and had met with very pleasurable success, which had been greatly owing to their labours. The duties which would have devolved upon Mr. Knight, had he been present, had been very ably performed by one of their Vice-Presidents, Mr. Stoddart.

The toast having been drank,

The Chairman returned thanks on behalf of himself and Mr. Cole, who was present, and of Mr. Hislop, who was absent. He felt almost oppressed with the duty of returning thanks, because, although they had conferred upon him the honour of presiding over the assembly, he was conscious that he had been a bad attendant at the Council, and was still likely to be so; but whenever his services would be of use to the Institute, its members might command them.

The Chairman then rose and proposed the health of gentlemen without whose exertions the company would not have been present. They all knew what the energies of a few individuals could effect, and what determined action and good counsel would bring about. Those only who had been in the habit of attending committees knew the amount of labour thrown upon their working members. Such institutions were carried forward by the exertions, not simply of men of luxury who hardly knew how to amuse themselves, but of men of business whose time and efforts were greatly engrossed. Such was the case with some gentlemen upon the Council. There were others outside that body who might come in, and who would be an honour to it, and whom he yet hoped to see among them again—as part and parcel of themselves. They must not expect that their own individual views would always be followed out in the path of life; amidst the bustling and crowding of various opinions, they must not expect always to be able to go in a direct line. In walking through the streets, in crowded throughfares like Cheapside or Cornhill, if a man found himself pushed off the path occasionally he must not be surprised; but he lost no respect on that account. Such persons would find themselves part and parcel of that respectable body which they first belonged to. Perhaps he might make some allusion to parties who thought that the Council had not altogether carried out their views. There had been some dissentients. If members of an institution would

only allow the joint wisdom and opinion of the majority to govern their actions, they might depend upon it that it would be benefited, and their objects would be carried out to a successful issue. He proposed the health of the Treasurer and Council, coupling with the toast the name of the former gentleman, Mr. R. R. Hux.

Mr. Hux, on behalf of himself and the Council, returned his best thanks to the Chairman for proposing, and to the meeting for the hearty manner in which they had responded to the toast. He was quite sure that if it were possible for any one thing more than another to stimulate the exertions of the Council in the cause of the Institute, it would be the handsome manner in which that meeting had recognised their services. It was impossible to advance a profession without at the same time improving the social condition of all connected with it. Knowledge was power; had the members of the trade arrived at such perfection that they might cease to learn? If not, in what way could they better promote their own interests than by supporting the British Horological Institute? The prosperity of the trade would be the fundamental principle to guide the actions of the Council, not only to expand, but to elevate it, and make its influence felt. He was glad to state that they were meeting with success, though he would say to all, It is your cause, it rests with you that by one single effort the British Horological Institute shall not only be a fact, but a great fact adapted to the requirements of the age. In the formation of the Institute their most strenuous endeavours had been directed towards adapting it for all,—not for one branch, class, or section, but for the entire trade. He would say, in the words of the poet,—

> "Men of thought, be up and doing
> Night and day;
> Sow the seed, withdraw the curtain—
> Clear the way!"

The Institute led men to think, and those who did so, to think yet more; then would follow action from what might be called its recognised centre, and thus it was impossible not to foresee that the Institute would have a rapid advance. Amongst the noble institutions of the country, let them look at the Royal Institute of British Architects, and the Institution of Civil Engineers. What these institutions were to those professions, that the British Horological Institute was to all connected with Horology. The Council desired the co-operation of those who wished their trade to be developed to the utmost extent, and thereby have an Institute that shall be recognised as the head-spring of future perfections in the art of Horology, —an Institute where future generations might seek the inspiring riches of scientific truths. They asked the cordial assistance not only of the trade, but of all lovers of the art of horology; then all would have cause to rejoice, and by their united efforts they would place the Institute upon so firm a basis, that it would endure—prove a source of usefulness to the horological community, and shine as the polar star of knowledge, when the promoters were no more.

The Chairman said that the next toast gave him peculiar pleasure to propose. It was formerly said that English workmen moved only amongst themselves, but the liberal ideas that had been created amongst them by free-trade from time to time had removed those notions. A great many Genevese gentlemen had been introduced into the locality, and he had not the slightest hesitation in saying that their productions had wonderfully improved the manufacture. The principles those gentlemen had brought over with them had done them great good. He proposed "The Foreign Members of the Institute, and the French Horological Institute," which was established about five years ago, and which had progressed most satisfactorily. He would couple with the toast the name of a gentleman well known in the trade and the metropolis, Mr. C. B. Klaftenberger.

The toast having been drank,

M. Klaftenberger said that himself and other foreign horologists had come into the country not only to get a livelihood, but for the sake of improving themselves in the art of watchmaking. He was one of those who, like their friend Mr. Cole, thought it was their duty and their interest to put their shoulders to the wheel, and to improve themselves for the benefit of the trade and the public generally. Most foreigners came to England with the view of improving themselves. The man who went through a village with his eyes open would find something in all probability that he had not seen before, and from which he might derive improvement; but in that large metropolis, where the art of watchmaking had been studied for centuries, and where men had spent fortunes to bring it to perfection, there were far more opportunities of deriving knowledge and improvement than in a small place. The members of the French Institute would be pleased and happy to hear of the kindly manner in which they had been noticed upon that occasion. He had been connected with the *Revue Chronométrique* from its origin, and was one of its founders. Although residing in London, he was connected with most of the watchmakers of Paris, and had been called on when it was started to join it, which he had done. When he mentioned that a similar Institute had been started in London, they expressed their willingness to join it, and to exchange journals. He would communicate to the members of the French Institute the kindly feeling which had been displayed towards them, and he hoped that both institutions might flourish for the good of the whole world.

The Chairman, in giving "The Trade Charitable Institutions," gave a history of their origin, commencing from the time when the watch tax existed, and when consequently people used to keep their watches hidden in drawers.

Mr. Carley responded to the toast, which was warmly received, and said he could not help thinking how simple-minded our progenitors must have been to tax things that could be hidden in drawers. Those were not the days of Disraelis and Gladstones. But this was not the only particular in which we had improved, and the use and growth of our Charitable Institutions was one conspicuous example of this. Mr. Carley then gave some interesting particulars in connection with the Trade Charities, and in conclusion expressed his

sympathy with Mr. Cole's views as to the revivification of the trade, and his hope that the efforts of the Institute among the young—the old ones had been too long in the groove,—would leap to that happy result.

The Chairman gave "The Visitors."

Mr. W. S. Wilson.—I feel much pleased at being present in company with so many celebrated for their skill in an art for which Clerkenwell has long been, and I hope will still continue to be, distinguished; and I am quite sure that the way to secure the pre-eminence hitherto attained will be to support the Institute they have so successfully established, and the object of which they have this evening so intelligently explained, by all the means in their power. This support will not only benefit every individual in every branch of the trade, and make more scientific if not skilful workmen, but will highly rebound to the credit of all connected with it, and especially those who by their exertions, wealth, and influence have brought it to its present proud position. As there are no doubt many here who will desire to congratulate you on your success, I will not longer occupy your time, but resume my seat by heartily wishing prosperity to the Horological Institute.

The Chairman proposed the health of the Hon. Secretary, Mr. Mylne, and in doing so warmly eulogized that gentleman for the services he had rendered to the Institute.

Mr. Mylne, in returning thanks, announced the following list of donations and subscriptions:—

Valentine Knight, Esq.	£10	10	0
Mr. Jas. Stoddart	10	10	0
Mr. Samuel Jackson	10	10	0
Messrs. F. B. Adams & Son	2	2	0
Mr. George Carley	5	5	0
Mr. E. J. Thompson	2	2	0
Mr. William Rowlands	10	10	0
Mr. Christopher Rowlands	5	5	0
Mr. F. S. Notterman	1	1	0
Mr. R. R. Hux	3	15	0
Mr. S. Jackson, extra	1	0	0
Mr. J. Murray	1	0	0
Sundries	2	0	0

The Chairman proposed "The Press," coupled with the names of Mr. Farmer and Mr. Russell, which was drank and duly responded to; as also was that of Mr. Gordon, the Editor of the *Horological Journal.*

Mr. Trewinnard proposed the health of Mr. E. D. Johnson, as the principal founder of the Institute, which was drank with warm applause, and was replied to by that gentleman. And the meeting separated.

DISCUSSION MEETING:—On the Art Decoration of Watches.

A Discussion on the "*Art Decoration of Watches,*" the subject of a Paper read by Mr. Schweizer, and reported in our last number, was held at the Institute on the 6th March, Mr. Webber in the chair.

The discussion was opened by—

Mr. S. Jackson, who said,—I find the task of commencing this discussion, which has accidentally devolved upon me, less easy than I thought it. Not being so practically acquainted with this branch of horological manufacture as others in whose hands it would have received ampler instrument, I trust that my inability to do justice to the importance of the subject will not deter others more intimately acquainted with the details of the art from taking a part in the instruction these meetings are intended to afford us. M. Schweizer's *resumé* of the historical eras of art decoration was very interesting; and, as correctly putting before us those broadly defined styles which, like a language, are identical with a national existence and expression, is valuable as guiding us to the indication of whatever description of ornament we may desire to employ. I think, if we might ask of M. Schweizer a further favour at some future time, it would make his interesting paper more complete and valuable would he furnish us with a correct specimen of each of the three great styles, each suitable to the ornamentation of a watch. A design in each style—in the Classic or Greek, in the Byzantine, in the Renaissance, and another in that which is historically connected with our own country for its development, the Gothic—would be both useful and instructive. M. Schweizer had not alluded to the necessary connection which should exist between the ornament on the dial and that of the exterior. Though the surface herein is extremely limited, and distinctness must be the prime requisite, ornament is commonly introduced; and where so, there ought to be a harmony in design to achieve any pleasing result or successful treatment. I cannot go the length of the author of that paper in ascribing the inferiority of the English engraver in his designs (if such inferiority exist) to the limitations imposed by the manufacturer. I believe that employers would only be too glad to avail themselves of superior taste in decoration, and to be absolved from the necessity of exercising control here. Till lately there has not been much evidence of care or anxiety for the proper treatment of this subject by engravers, and which a collection of designs would best prove. An experience of my own will illustrate what I mean. A watch case (exhibited) I wished ornamented in that beautifully florid style, the Byzantine, as admirably seen in the Alhambra Court of the Crystal Palace, whence this design is taken. The band of this case remained to be engraved; and, time pressing, I requested it might be ornamented with a corresponding and suitable ornament; and here you see is a common laurel wreath put on it, although the forms of plants are rigorously excluded from this style. Here, at least, the option was not advantageous. But, I think, if the Institute succeeds in its aim of establishing class instruction, such anomalies will cease to exist, and we shall not have to look for superior designs or adequate taste, as we have equal if not greater facilities in obtaining the best models of any country.

Mr. Jackson here read a paper containing a few remarks from Mr. Storer, who had sent a framed engraving, executed by his (Mr. S.'s) father, of a very ancient watch:—

"The engraving introduced properly belongs to the subject under consideration this evening, being illustrative of watch art decoration at a very early period. By the description of the works contained in the case, we at once discover the superiority of the decorative art over the mechanical. Nor will this be surprising, when we consider the probable date of the work to be not very long subsequent to what are usually denominated the dark ages—a period famous for the domination of the priesthood, who, amid the gloom of ignorance, succeeded in rearing magnificent structures adapted to the pageantry of their worship, and whose genius was expended upon the decoration of the edifices. Lay ingenuity would naturally flow in the same channel. The wants of mankind were few, and hence mechanism would be of but slow development. This fact is evidenced by another fact. According to the "Horological Journal,"* about 180 years elapsed from the invention by De Vic to the period of the construction of the first time-piece. By the Journal we also learn, that at Brussels an individual possessed a clock which was set in motion by a straight spring, which was nothing more than a sword-blade, the point of which was attached by a cord to a barrel around which it was wound. Considering that the motive power of this ancient watch was of the same kind, it is not improbable that it was made at the same period as the clock at Brussels. But then neither bear any date. It is not unreasonable to suppose they may have been made a short time prior to 1525; for it is not likely so crude an idea as the straight spring would, even at the time in question, remain long unimproved, and we find in 1525 an improvement attempted, in the first time-piece on record, made by Jacob Leach, of Prague, and which possesses a fusee and a spiral spring as the motive power.

"We have now considered the probable state of this ancient watch, and given a reason why the decorative art is superior to the mechanical. If our friend M. Schweizer, with his aptitude for research of this kind, can discover any characteristics in the decoration of the watch which will stamp it as belonging to a particular period, he will by its announcement interest the members of the Institute, and enlarge the history of horology."

M. Julien Faucherre's remarks, which follow, were then read from the chair, the writer being unable, by reason of ill-health, to attend:—

"Gentlemen,—Engraving is entirely dependent on Drawing. In order to produce a decoration according to good taste and agreeable to the eye, it is absolutely essential to know the art of drawing in all its branches. The decoration of a watch, a jewel, &c. consists in covering the piece with some regular pattern, or in engraving thereon a design from a drawing in an appropriate style; and, for the execution of such design, the graver must be in the hand of the artist like the pencil or brush in the hand of the draughtsman. The latter, it is true, has an advantage in the use of different tints, in gradation from black to white, to give a relief to his subject; but still the engraver, though deprived of the actual employment of those tints, must equally give the due relief to his subject. In this case an accurate knowledge of drawing comes to his assistance, and it comes to alleviate his task, by the use of divers cuttings to represent the different colours, namely, bright cuts for the effects of the different lights, dead, yellow, and black cuts, &c. according to the design he has to execute; and these he must employ with discernment, following scrupulously the lines of the drawing, which is nothing else than a copy of nature. A few natural flowers grouped together with taste on a sheet of paper would furnish an excellent model for an engraver to copy from; for there he has the shades reflected on the paper, and by employing with skill the different tints I have before-mentioned he will come with facility to give so much relief to his design as to deceive the most practised eye and tempt the finger to pass over it to ascertain the real nature of the relief.

"I have remarked, in engravings executed by a workman ignorant of the art of design, that he cuts his subjects always in the same manner, and, to give what he calls *effect* to his work, he finishes by spoiling it entirely, putting bright cuttings without any discernment right and left, and in every direction, so as to destroy entirely the few shades which his design possessed. I repeat therefore what I have before said, it is absolutely impossible to be a good engraver without a thorough knowledge of the art of drawing in all its branches. Considering an engraving by itself, it is nothing else than a picture executed by the graver. A perfect knowledge, therefore, of the principles and capabilities of his art makes the engraver an artist, for it calls forth in him the genius of creation or invention; while, on the other hand, I consider one who is destitute of such knowledge as nothing more than a workman—more or less capable—for he cannot produce anything else than a copy, better or worse it may be according to his capacity;—in one word, he is like a fiddler without a knowledge of music. The absence of such knowledge will always confine him to the same limited sphere Thus engraving will remain at the same point—nay, I may with confidence affirm, it will lose more than it gains, from the manner in which apprentices are now being generally brought up, of which I will give you a slight idea. Gentlemen, the masters of Engraving and Dial-finishing establishments in London are in continual opposition one against another, and doing for those that work at the lowest prices; yet, with all this, these gentlemen are desirous of making a fortune as rapidly as possible; and, to arrive at that end, they take into their service as many youths as they can from all classes of society. When these unfortunate youths can cut a parsley leaf or any thing else on a bizzle, they are kept at that work nearly the whole of their apprenticeship. When they are out of their time, what are they are able to produce? Without any knowledge of the principles of their art, they are dismissed to make room for others. During their apprenticeship they have tried to imitate as much as possible what they have seen done; and afterwards with a few bad specimens of their work they go about offering their services at the lowest possible price—not enough to keep them, though too much for the quality of their work—earning thereby not even the wages of a

* See Horological Journal, No. 7, Vol. I., p. 88.

journeyman carpenter, as remarked by Mr. Wilkins. Gentlemen, remember the remarks of Mr. Klaftenberger at the reading of M. Schweizer's paper. Twenty years ago the engravings were pretty and in good style, and were sent to Geneva to be copied on their watches for the English market. The remark is quite true. I used to admire those engravings, and more particularly on the dials. But for the engraving of a case there was then paid to the workman from 15*s*. to 25*s*., and for the dials from 4*s*. to 6*s*. and more. At that time there was no opposition—the prices were regular everywhere. The present prices, I understand, are from 1*s*. 6*d*. and for the dials from 6*d*. Gentlemen, it is deplorable to see the fallen state of so beautiful an art—of an art which, when the work is well done, is of so great assistance in the sale of watches, &c.

Mr. Clifton showed some very clearly defined plates, the result of electro-metallurgic deposit, in which the lines had almost the sharpness of the graver cut, which were produced by Mr. Howard, and which, Mr. C. thought, proved that this process might be brought in to aid engraving in such designs. He thought ornament to watches did not necessarily stop at the dial and case; he had seen what he thought beautiful effects produced by embellishing the interior of watches, such as giving a design to the balance of a costly watch, and where the escapement was placed in a circle cut out in the dial, and in other ways, all which tended to employ skilled labour. There was enamelling, also, to which Mr. Schweizer had not referred. In conclusion he would say, that he looked to the Institute, by the classes and such discussions as might take place in it, to open up information and avenues of employment to the workmen; and although he knew there was much indifference manifested towards the Institute by those who, like himself, depended upon their labour for their existence, he emphatically said it (the Institute) was a workman's question. By means of the Institute we may hand down to our children what our forefathers were perhaps unable to transmit to us, and our children will benefit beyond what we can.

The Chairman said, he did not expect to be able to add much to the interest of the evening, as his vocation was more connected with the mechanical construction of a watch than its embellishment, and he could have wished there had been more professional aid present. He concurred in the opening remarks, which he thought showed considerable interest in the subject. He could not, however, be silent on the importance of at once establishing a class for Drawing in the Institute, as upon a knowledge of that, all seemed to concur in affirming, success in any degree depended as to their obtaining artistic engraving.

Mr. Warman stated, that although his practice as an engraver was confined to the internal engraving and ornament of the watch, his daily experience in teaching apprentices impressed upon him the absolute necessity of all engravers being qualified by a knowledge of drawing; and those only, in his opinion, who had such were at all likely to excel. The most able apprentice he had was one who had made much progress in his drawing class; and he put on the table a brass circle covered with very nicely executed designs suitable for the inside engraving of a watch, the production of this lad. He thought a better knowledge of design much wanted; in watch engraving he had seen frequently a well-friezed centre of a watch dial spoiled by a series of bright cuts round it scarped out, when if the surface had not been touched a much better effect would have resulted. This knowledge the Institute, he trusted, would be the means of affording.

Mr. C. Guillaume, being called upon to give his opinion, said, he thought there had been a prejudice in the trade against decoration. In this age of railways we thought we had become very practical and wise in discarding ornamentation; but, in so doing, we had departed from the teachings of Nature, which clothes every object with as much beauty as is compatible with usefulness. We had gone so far as almost to think that a first-class watch would lose its quality by being put in a handsome case. But there was no reason why a little more labour and taste should not be expended in making a watch as beautiful as it is good. There had been a fear lest this change should be an imitation of Geneva work; but it must not be an imitation, for that never gives a proper impulse. Decorators must copy neither Swiss work nor old English art;—we have gone past that. They must strike out a path of their own, remembering that each nation, and each age, have their own distinct tendencies. We see it in architecture (even that of private dwellings), in painting, &c. Engravers should by proper study make themselves masters of their art, to find out the style suited to the present want, and to execute it according to the laws of art; then will they see good taste revive, and their efforts seconded by the trade and the public.

Mr. Schweizer, in reply, said, he had not said anything as to enamelling in his paper, but he thought that was more likely to be pre-eminent in Geneva, from several causes. He had seen enamelling well done in Clerkenwell, but it was seldom the engraving was suitable. In Geneva there were engravers specially for enamelling. However capable an engraver might be, he would without practice and experience quite fail in producing a good effect in preparing for an enamel. Then, again, Geneva had advantages over London or Paris in the air, which was clearer; again, the noise, dust, and clouded atmosphere of a large city were unsuited to this delicate process; something there might be in the water, too. No one could doubt the talent, both as chemists and artists, of the Paris workmen, which was not surpassed anywhere, yet they could not equal the productions of Geneva in these works. Fully appreciating the great experience and artistic ability of Mr. Faucherre, he yet could not agree with him, if he put the absence of superiority in English watch engraving to the score of price. Free competition it was which had brought about the present high state of excellence in art engraving in Geneva. There, to his knowledge, not one, nor two, nor three first-class artists were to be found, but a dozen or more. Something must exist to keep back the developement of English talent, and he still thought that employers were much responsible for it.

BRYSON'S NEW GAUGE FOR MEASURING WATCH GLASSES.

Fig. 1.

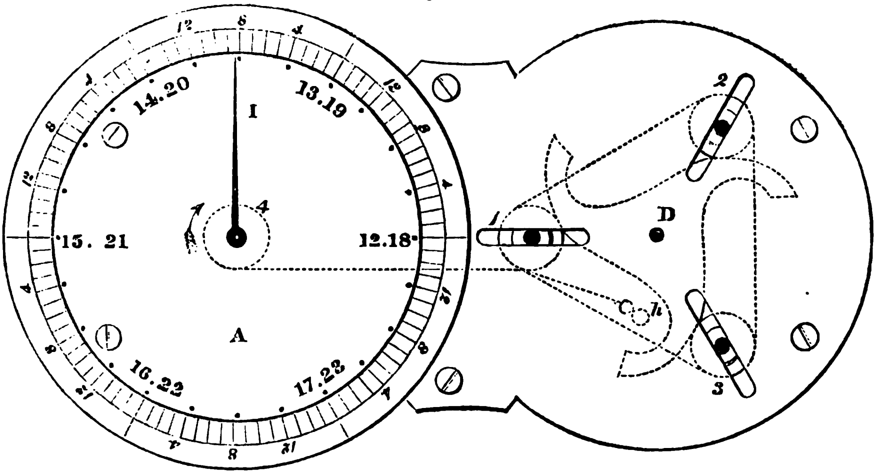


Fig. 2.

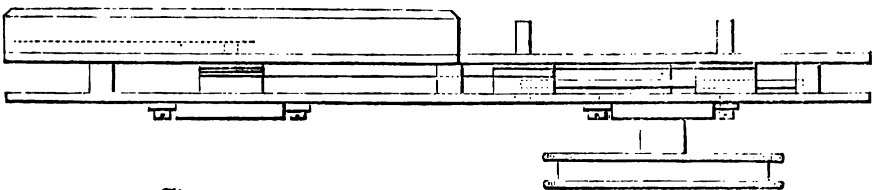
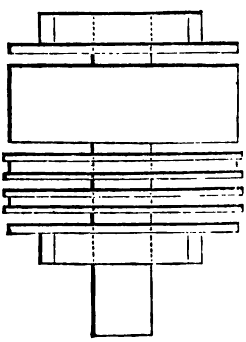


Fig. 3.



On a New Method of Measuring Watch-Glasses. By ALEXANDER BRYSON, F.R.S.E., Her Majesty's Clockmaker for Scotland.*

The method hitherto employed for gauging watch-glasses was by a nonius scale, divided into centimetres, each of which were again divided into sixteen equal parts. By this method considerable accuracy was obtained in measuring the diameter, but as most watch-glasses have a certain amount of ellipticity, it gave no true indication of the extent of the circumference. To obtain the proper size of the glass, it required to be rotated on the scale, and the ellipticity estimated by the difference of the diameter.

This process was necessarily slow, and at least uncertain; and as the lines on the nonius scale are fine, considerable acuteness of vision was indispensable.

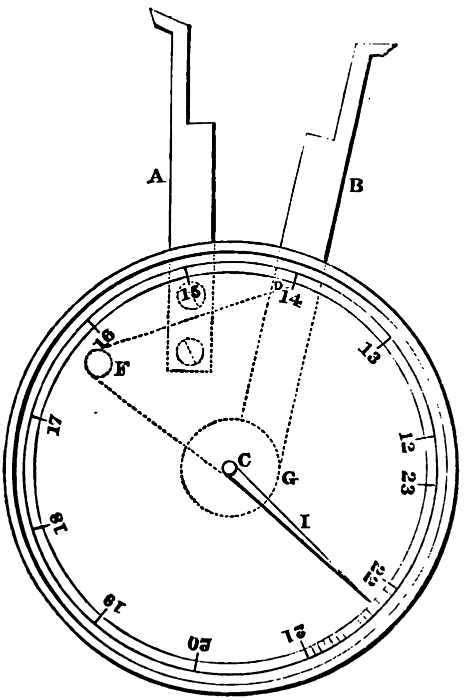
Some idea of the difficulty of measurement may be formed, when we find that the difference between size 12, the smallest, and 23, the largest glass, is only ninety-five hundredths of an inch (·95), which has to be divided by the nonius into 176 equal parts. This difficulty is also increased by the ellipticity in the larger glasses, amounting in some instances to three, or even four sizes.

To obviate these sources of error, the gauges to be described were constructed.

Figure 1, in the Engraving, represents the gauge used for ascertaining the circumference of the glasses. It consists of two plates of brass, one fifteenth of an inch in thickness (0·066), supported on six pillars two-tenths of an inch in height (0·20). The positions of

* Read before the Royal Scottish Society of Arts, and Drawings and Instruments exhibited, 25th April, 1859. Awarded the Society's Silver Medal.

Fig. 4.



the pillars are indicated by the screw-heads in the drawing. Numbers 1, 2, and 3 are hardened steel rollers, forty-one hundredths of an inch in diameter (0·41); they have each two pivots, working in steel sliders, which fit accurately into the three slots in the front or upper plate, and also into three corresponding slots in the plate below. The pivots in the upper plate protrude above it two tenths of an inch (0·20), and embrace the glass at three points of its circumference. The breadth of the slots in which the slides or pivot carriages move is one-tenth of an inch (0·10), and six and a-half tenths in length (0·65), giving a range sufficient to measure glasses from size 12 to 23.

C is a fine watch chain, fourteen inches in length, attached to a hook fixed to the front plate at *h*. This chain works in a grooved gun-metal roller, placed on the pivot of roller No. 1; it is then conducted to a similar grooved roller on No. 2, and then to roller No. 3, which also carries a gun-metal grooved roller. The chain is now warped round a grooved steel roller on No. 1, but above the gun-metal roller formerly described; it is then carried round a hardened steel cylinder, No. 4, which is of the same exact diameter as the other three—viz. 0·41 of an inch. The chain makes two and a-half revolutions round this cylinder, and is attached to it in the *same way as* a watch-chain is to the mainspring barrel, by means of an oblique hole drilled into it for the reception of the hook. On the axis of the cylinder No. 4 is placed the index or pointer I, indicating on the dial A the size of the glass to be measured. The pivot of this cylinder proceeds through the lower plate 0·30 of an inch, and has attached to it a watch mainspring, which tends to turn it in the direction of the arrow; by this means the chain is wound round the cylinder, and the three rollers are pulled towards the centre.

If a glass be now placed within the three pivots, it will be embraced at the corresponding points of its circumference, and the value indicated by the pointer I.

If any depression or ellipticity exists at points 1, 2, or 3, the exact amount must be told by the index, as each roller is independent of the others, and thus the extent of the periphery of the watch-glass ascertained with precision.

D is a cam-wheel with three epicycloidal curves, for the purpose of extending the rollers. The axis of this wheel is pivoted in both plates; on the upper it is level with the plate, but extends through the lower 0·50 of an inch; to this another watch mainspring is attached, tending to throw the epicycloidal arms outwards, and is of such a strength as nearly to counterbalance the spring on the axis of the index. Beyond the box which contains the mainspring, the axis is squared, and a milled head adapted, by means of which the hand is enabled to throw out the rollers for the admission of the glass to be measured.

A is the dial divided into ninety-six equal parts, each division being the equivalent of the sixteenth part of a centimetre. We are thus enabled to measure watch-glasses with an instrument which corresponds with the gauges used at Geneva, and by the principal manufacturers in England, with an amount of accuracy hitherto unattained. The ease of reading the new gauge, as compared with the old one, is as 15·5 to 1, and the increased accuracy in the same ratio.

Figure 2 in Plate is a side view of the instrument, and shows the disposition of the chain round the rollers and index cylinder. It exhibits also the main-spring boxes at A and B, and the milled head D, by which the rollers are extended.

Figure 3 in Plate is an enlarged representation of roller No. 1, with its five pieces separated, to show their positions; the sliding pivot-carriage above and below; also the position of the gun-metal grooved roller, and the steel one of double thickness, on which the chain is warped one whole turn

before being attached to the cylinder or index axis.

By thus warping the chain round the roller No. 1, the relative angles which the three rollers make in all positions with the cylinder axis are the same, and hence equal increments of size in the watch-glasses are indicated by equal spaces on the dial.

The annexed table exhibits an analysis of the measurements of 9778 glasses made by the instrument to test its accuracy as against the standard nonius Geneva gauge. It is necessary to remark, that all these glasses had been twice sized and marked—first by the makers in Geneva and London, and secondly by myself—before they were passed as correct, and placed in their cells, where they are kept according to their sizes. These glasses were all, therefore, as accurately sized as the former method was capable of attaining, and gave me an opportunity of testing completely the value of the new instrument.

The upper portion of the table shows the measurements of the Geneva glasses, and the lower of the English. The first column contains the sizes, where $12\frac{0}{16}$ is the smallest glass in ordinary use for Geneva watches up to $23\frac{0}{16}$ the largest; each number, therefore, from 12 to 23, contains sixteen sizes of glasses.

The second column contains the number of glasses which were found rightly sized by both methods, and the third column those that were found wrongly sized, as detected by the new instrument.

The fourth column shows the difference of the right and wrong-sized glasses, and in the fifth is exhibited the proportional difference per cent.

From this analysis it will be seen that the old method, although very faulty in all the sizes, measured the smaller glasses more accurately than the larger; but this arises from the fact that a small disc has less chance of being elliptically ground than a larger one.

This fact is shown in the third column, where 163 glasses of the largest sizes had been passed as correct by the nonius gauge, but were all found wrong by the new instrument. From the greater number of elliptical than circular glasses (nearly double) as shown by the table, no mere measuring of the diameters by a nonius scale can give the true value of the circumference.

Were this gauge adopted by watch-glass manufacturers and watchmakers, an immense amount of time and labour would be saved; and if the measurements given in this paper are strictly adhered to, all the gauges would be comparable with the standard now in use in England and on the Continent.

Analysis of Measurement of Geneva and English Watch-Glasses.

Sizes.	Right.	Wrong.	Difference.	Prop. Diffe. per cent.
GENEVA.				
$12\frac{0}{16}$ to $12\frac{15}{16}$	131	115	R 16	+ 6·5
13	193	157	R 36	+ 10·2
14	141	188	W 47	— 14·2
15	92	274	W 182	— 49·7
16	73	310	W 237	— 61·9
17	110	235	W 125	— 36·2
18	56	194	W 138	— 55·2
19	66	212	W 146	— 52·5
20	26	259	W 233	— 81·7
21	11	311	W 300	— 93·1
$22\frac{0}{16}$ to $23\frac{0}{16}$	0	163	W 163	— 163·0
ENGLISH.				
$14\frac{0}{16}$ to $14\frac{15}{16}$	81	101	W 20	— 10·9
15	144	364	W 220	— 43·5
16	663	755	W 92	— 6·4
17	488	533	W 45	— 4·4
18	420	620	W 218	— 21·3
19	421	639	W 218	— 20·5
20	152	315	W 163	— 34·9
21	234	328	W 94	— 16·7
22	63	158	W 95	— 42·9
		3547	6231	
			3547	
Total number measured......			9778	

Figure 4 in Plate is the gauge employed for measuring the bizzles in which the glasses are fitted. A is a fixed bar bearing a steel point; B is a moveable bar with a similar steel point; G is a barrel attached to the bar B, containing a watch main-spring, tending to throw the bar outwards. A fine watch-chain is attached to the moveable bar B at O, it is then conveyed over a steel roller at F, and from thence to a steel axis at C. The axis C bears the index I, which points on the dial to the size of glass required. A watch balance-spring placed on the axis C keeps the chain always tight. The dial is divided into 22 parts, each again divided into 16 equal parts. By the construction of this gauge the divisions are not precisely equal: from 12 to 23 there is a slight diminution of the spaces; they are, however, accurately adjusted to the gauge for measuring the sizes of the glasses, and when applied to the bizzle of a watch, it points at once to the size which is applicable.

degree of perfection has not yet been obtained."

*** At the words "anchor escapement," p. 55, line 3, the following should have been added as a note :—

"The anchor escapement is represented in Plate V. fig. 1, of Berthoud's *Essai sur l'Horlogerie*; and that with a double lever in Plate III., figures 5 and 6 of the same work ; also in Plate XLIII., fig. 30, of Thiout's *Traité de l'Horlogerie*; but the first figure is the best. An ingenious watchmaker has lately considered this as a detached escapement, and supposes it to be the first that was invented ; but it does not appear how it can be reckoned of that kind.—T. S. E."

DOUBLE VOLUTE BALANCE SPRING.

To the Editor of the Horological Journal.

Sir,—Observing, in No. 19 of the Journal, Mr. Hammersley's description of a double flat balance spring, the principle, form, and effects of which are identical with the form and properties of the Double Volute Spring mentioned in the notice published by me four months earlier in No. 15 of the Journal, (page 45), I desire to say that the kind of spring there referred to was originally devised and successfully adopted by me in various watches, some of which in use for 30 years, have been submitted to many watchmakers and recognized as my invention.

This spring was in the first instance formed of a single length of hard drawn wire, coiled equally at each end of the wire, and correctly formed as a pair of flat spirals of about seven coils each, the outer coils meeting in the same plane at the middle of the length of wire, and in that state set flat by blueing ; the portion of wire between the two spirals was then curved by bending, so as to bring one spiral concentrically over the other, and the outer coil gradually inclined so as to separate the plane of each spiral sufficiently for the required freedom ; after this the lower end was attached to a very small collet fitted on the balance axis, both spirals made true, and, in order to *set* the outer bent coil, the spring was again submitted to a heat sufficient for that purpose, the upper end being attached to a suitable stud of the same radius as the collet from the centre of motion.

This double spring occupying no more height in the frame than the Breguet overcoil, is well adapted to flat watches, though the original Double Volute Spring was applied by me to a full-sized pocket chronometer. Such springs, when produced by machine principles as tempered springs, may be used advantageously in marine chronometers and watches with compensation balances, as the more equable action of this spring lessens the eccentric force and position errors of the watch, as stated in my former notice. I do not, however, admit that springs of this description possess any higher property of isochronism, as *that* is a result entirely dependent on the various mechanical conditions of its application.

I disclaim having adopted the Double Volute Spring as a remedy for acceleration on rate, though my final mode of attaching the spring to the collet and stud required no bending of the wire, which was left undisturbed after tempering and blueing.

Your's respectfully,

14th March, 1860. J. F. Cole.

EQUATION OF TIME TABLE

For April, 1860.

Day of the Week	Day of Mnth	At Apparent Noon — Equation of Time to be *added* to Apparent Time.	Difference for One Hour.	At Mean Noon — Equation of Time to be *subtracted* from Mean Time.
		m. s.	s.	m. s.
Sun...	1	3 49.61	0.756	3 49·65
Mon...	2	3 31·47	0·751	3 31·51
Tues..	3	3 13·46	0·745	3 13·50
Wed ..	4	2 55·58	0·738	2 55·62
Thurs.	5	2 37·88	0·730	2 37·91
Fri. ..	6	2 20·37	0·721	2 20·40
Sat. ..	7	2 3·08	0·712	2 3·10
Sun...	8	1 46·00	0·701	1 46·02
Mon...	9	1 29·19	0·689	1 29·21
Tues..	10	1 12·66	0·677	1 12·67
Wed ..	11	0 56·41	0·664	0 56·42
Thurs.	12	0 40·48	0·650	0 40·49
Fri. ..	13	0 24·88	0·635	0 24·88
Sat. ..	14	0 9·63	0·620	0 9·63
		subtracted from		*added* to
Sun...	15	0 5·25	0·605	0 5·25
Mon...	16	0 19·77	0·589	0 19·77
Tues..	17	0 33·89	0·572	0 33·89
Wed ..	18	0 47·61	0·555	0 47·62
Thurs.	19	1 0·92	0·537	1 0·93
Fri....	20	1 13·81	0·519	1 13·82
Sat. ..	21	1 26·26	0·500	1 26·27
Sun...	22	1 38·27	0·482	1 38·28
Mon...	23	1 49·83	0·463	1 49·84
Tues..	24	2 0·93	0·443	2 0·94
Wed ..	25	2 11·57	0·423	2 11·58
Thurs.	26	2 21·73	0·403	2 21·75
Fri. ..	27	2 31·41	0·383	2 31·43
Sat. ..	28	2 40·60	0·362	2 40·62
Sun. ..	29	2 49·29	0·341	2 49·31
Mon...	30	2 57·48	0·319	2 57·50

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THE BRITISH HOROLOGICAL INSTITUTE.

Classes for Instruction in Geometry and Drawing.—These Classes are now in active operation. Lessons are given, at the Rooms of the Institute, in Geometry once a week, and in Drawing twice a week. The course commenced on the 19th of April. Fee, 5*s*. per quarter for the Geometry Class, and 7*s*. per quarter for Mechanical and Ornamental Drawing, or 10*s*. per quarter for Pupils joining both Classes; the fee, payable in advance, includes all Drawing instruments and materials except a board and T square.

The Council would again respectfully urge upon Parents and Employers the great importance of allowing those under their care an opportunity of attending these Classes, which are offered on terms of great advantage, and which by adding sound theoretical knowledge to practical qualification must benefit them by enlarging their understanding of mechanical principles.

All particulars as to membership may be obtained on application at the Institute.

Notice to Members.—It is requested that all Books obtained from the Library be returned to the Honorary Secretary on or before Tuesday the 15th instant.

Professor TENNANT'S LECTURE.

On Mineralogy, with especial reference to Watch Jewelling.

On the 17th April, in accordance with previous announcement, Professor Tennant, of King's College, delivered a Lecture for the Horological Institute, upon the above subject, at the School-room, Amwell-street.

Mr Cole, having taken the chair, briefly opened the proceedings, and introduced the Lecturer.

Professor Tennant said, he appeared there to give the meeting a dissertation upon a subject materially interesting to watchmakers. The other evening when he was at the festive board of the Horological Institute, at the Freemasons' Tavern, he was unexpectedly called upon to reply to a toast, and in doing so he offered that, if it would be useful in suggesting any materials for thought to the younger members of the profession, he should have much pleasure in giving them an hour's talk, as it were, upon the science of Mineralogy; and he was there that evening in fulfilment of his promise.

In the present day, mineralogy and geology had taken a very prominent hold of the public mind; there was scarcely a person who did not know something about them. If a man now picked up a stone, he did not need to ask what it was, but he was to some extent acquainted with its nature It was a great pleasure to him, in visiting the British Museum and similar scientific institutions, to observe the general information possessed by the working classes concerning their contents, and especially by young people. On Easter Monday last he had listened to some remarks from visitors at the British Museum, which thirty or forty years ago could scarcely have been made by persons in high stations of life. There were exhibited in various shops of the metropolis diagrams of the earth's strata. In the one upon the wall of the room they would perceive that the position of London was marked. Proceeding from thence to Holyhead the traveller would pass over every one of the beds indicated in that drawing. He (Professor T.) would describe the varied character of country traversed between this metropolis and Dublin. The old coach road made the traveller familiar with the various local peculiarities of country; but railways, when they meet with formidable impediments in their way, tunnel through the hills instead of passing over them, giving less opportunity for noticing the surface of the earth. From London to St. Alban's the travellers went through a tertiary formation—a kind of clay. From thence to Dunstable there was chalk, and afterwards a rubbly limestone, called oolite. At Rugby they came to red sandstone, which continued to Birmingham, where extensive manufacturing operations are carried on, entirely owing to the geological character of the district, where coals are plentiful and moderate in price—a circumstance which enables the manufacturer to render other materials subservient to his wishes. Proceeding from thence to Wolverhampton, they were in the midst of coal measures. At Chester that particular character of strata was

lost; and from thence to about Conway there was a series of rocks of a totally different nature Going on to Holyhead they came upon rocks of a slaty kind; and on landing in Ireland they found granite Let them vary the journey in imagination and suppose that they were proceeding in another direction, from the metropolis to Dartmoor. From here to Reading it was what was called "London clay;" then it became chalk; ten or fifteen miles further oolite beds appeared; from Bath to Bristol a series of rocks of a totally different character presented themselves, and in the neighbourhood of the latter city they came upon coal measures. Proceeding from thence to Exeter, they found the series of rocks indicated in the diagram; and from thence to Dartmoor they passed over the crystalline rocks. Those journeys would give some idea of the earth's variation of character. No country in the world affords the student such an opportunity of studying geology as the British isles, presenting as they do every conformation with the exception of two. Out of sixty formations known to geologists, fifty-eight exist here. In consequence of the facility afforded by cheap and rapid transit from one district to another, a young man who wants a few weeks' recreation in the summer has the best opportunity of studying geology which can be obtained anywhere. In foreign countries, and especially Germany, he had commonly met with thirty, and sometimes a hundred, young men, in the course of one day's journey, travelling with knapsacks on their backs, wending their way from place to place for the improvement of their minds and the extension of their knowledge. He was desirous of seeing a similar feeling in this country, for by such travels they would be enabled to cheat the doctors, and to lay in a good stock of health for the winter season. A man of intellectual mind and good memory sees the wonders of Nature spread out before him at every step of his journey. His (Professor T.'s) object, however, was to devote half an hour or so to explaining the characteristics of the stones before him To go into details respecting the various rocks would be a long and troublesome story.

No doubt there were some persons present who were unacquainted with the science of geology, and to them he specially wished to address his observations. Amongst the specimens of rocks before him, he would ask, for example, what a piece of granite was composed of? It was made of three simple minerals—quartz, feldspar, and mica. Another specimen he held in his hand was a piece of sandstone, composed of quartz, mica, and a little clay. When they spoke of those old rocks, they went back by long periods of time, for years they had no conception of, in geology. When the granite rocks were thrown up by volcanic action, they had no idea; all they knew was, that they were formed from still older rocks.

The mineralogical department comprised about 500 apparently distinct minerals, about 300 of which are found in the British isles, the remainder being distributed in various other parts of the earth. The greater portion of the stones used by watchmakers were brought from foreign countries. About a dozen were employed, the principal of which were the diamond, sapphire, oriental ruby, spinel ruby, beryl, and chrysolite. There were a few others, such as the garnet and the pyreto-rock crystals, used for the cheaper kind of jewelling.

Of what was a watch composed? The glass, which was pieces of flint or particles of sand, was derived from the mineral kingdom, and so was the case, whether made of gold, silver, or other metal; and the works, the brass being a compound of zinc and copper, and the mainspring of iron. It would naturally be asked, of what were the stones, a large number of which he had in the case before him, composed? Upon examination they would be found to present various characteristics. He held in his hand a rough piece of calcareous spar; he had found the same in Devonshire and in Derbyshire. There were before them two pieces, which, at first sight, appeared very dissimilar in character, but which, in fact, were but one substance—pure carbonate of lime. He had selected it because it illustrated a most important character, viz. cleavage of the mineral kingdom. There were modes of identifying them, which he would explain similar to those which existed in other branches of the natural kingdom. A botanist going to Kew Gardens would distinguish the plants by their stems, leaves, and flowers; the zoologist, in the gardens at Regent's Park, classified the animals into the carnivorous and herbivorous—those which lived severally upon herbs and flesh, each possessing its peculiar anatomy; so was it with the mineralogist in the British Museum.

The first peculiarity of minerals he would notice was their *crystalline form*. It was the property of mineral substances, under favourable circumstances, to assume definite forms. According to the best authorities, calcareous spar has no less than 650 forms of crystal, more than 300 of which are found in the British Isles. In 1808 Count Bournon, a French refugee, published a very valueable work, describing the crystalline forms of this substance, which might be divided into three groups—one a rhomb; another, a six-sided prism; and the third, a double six-sided pyramid. Another mineral, the diamond, was crystallized in almost 100 varieties of forms, belonging to what was called the "cubic," or "tessular" system, the most common of which were given in one of the diagrams upon the wall. Persons unacquainted with diamonds would scarcely recognize them in their native state. Being rather curious in matters of that kind, he went to the late Mr. Dobson, a large importer of diamonds, and asked to look at some. He took a handful of them, and spread them on the table. They were taken from a large quantity. He never before saw such a sight in his life; and upon his expressing surprise, the gentleman took another handful, and threw them upon the table like marbles. He (Professor T.) enquired whether he thought that, if they were put upon the pavement of Cheapside, one passenger in ten thousand would pick them up Mr. Dobson did not think they would. In their natural form diamonds are devoid of lustre, and different in form to what they are when manufactured. It was the general impression of geologists that in those countries where gold was found in considerable quantities, they were throwing away the diamonds, because they did not know them. That was the state (exhibiting a specimen) in which the diamond was found; the first step in the crystallizing, which

might be termed the flower of that mineral, to show the importance of which was one object of his visit there. He held in his hand a crystal of quartz brought from California by an eminent traveller, who purchased it there along with some gold specimens. Previous to leaving that country the gentleman took it to a jeweller to learn from him what it was. The jeweller first tried if it would scratch glass, which he found it would readily do. He next applied the file, and found that it would not touch it. It was highly brilliant—a prominent characteristic of the diamond—and was not dissimilar in form. From those features of the stone the jeweller said he thought it was a diamond, and offered to give £200 for it. The gentleman thought that if it was worth that to the tradesman it was quite as valuable to him, and as he was going to England he determined to take it with him. He showed it to several jewellers in London, and he (Professor T.) was sorry to say they could not tell him what it was. At last the gentleman brought it to him, and said that it was a diamond. He (Professor T.) replied, to his surprise, that it was not—that it was nothing but a piece of quartz crystal. He showed him that it was not the ordinary form of a diamond. He was not satisfied and therefore he (Professor T.) offered to break it, which the gentleman immediately objected to. He (Professor T) then took another substance exactly like it and broke that, and showed him the difference between that and the diamond.

The next step in the process is to study what is called the *physical structure* of the mineral—first the external form, and next its peculiar fracture when broken. There was no difficulty in breaking a stone, however hard. He wished to caution his audience against a very prevalent mistake with reference to the quality of the diamond. Practical jewellers should be careful not to ill-use it. It was one of the most brittle of substances. It broke readily in four sections. Pawnbrokers and others frequently broke diamonds by careless usage. In a rough piece of stone all the crystal features are absent, and it has nothing more than the common form, such as in the specimen he held in his hand; but if a diamond is broken, the fracture would be in the direction shown upon the board behind him, with a perfectly smooth face. The white topaz, or Nova mina, which was frequently mistaken for the diamond, when struck at a particular point would break right across, but when struck in another direction it would break with a curved surface. The two substances were so frequently mixed up together, and were so much alike in colour, that great disappointment was often occasioned by one being mistaken for the other. No sense of man was so easily imposed upon as that of sight. The fractures in the two substances when broken would be found totally different. Jewellers accustomed to work stones were acquainted with the fact; they frequently found flaws. A diamond was often rendered imperfect to the watch jeweller in consequence of a line of cleavage which ran across it. By the kindness of a member of that Institute, he had an opportunity of testing some in a transition state in the course of manufacture, and pointed out some defects which were owing to the steps taken in the breaking of the stone. He held in his hand a piece of calcareous spar, a substance picked up in the beds of rivers in various parts of the country. It broke more readily than the diamond, but in a form which gave such a smooth surface that it appeared as if cut by a lapidary; it was a perfect rhomboid. Placing that same calcareous spar in a mortar, and reducing it by a pestle to a powder so fine as to be invisible to the naked eye, it would be found that every particle of it retained the same form. If he took fluor spar, and broke it, the surface would be found as smooth as the last. Its form was, however, different; it broke into three forms, viz., rhomb, octahedron, and tetrahedron, which is the same as the diamond.

The next character of the diamond to be referred to was its *frangibility* or *brittleness*. Its next quality was that of *hardness*, which was very important in the estimation of mineralogists. In the old works upon the subject, the diamond was described as "hard" or "very hard"—terms so vague that a Table of Hardness had been substituted for them. The diamond was called No. 10; the sapphire No. 9; the topaz No. 8; the quartz No. 7; the feldspar No. 6; and so on, descending in the scale to No. 1. In grouping those minerals, they found that of No. 1 there were 23 different substances; No. 2 had 90; No. 3 had 71; No. 4 had 53; No. 5 had 42; No. 6 had 52; and No. 7 had 26. Those used by watchmakers were chiefly confined to Nos. 8, 9, and 10. In selecting a substance for watch purposes, it was very important to ascertain whether one was equal in hardness to the other. He held in his hand a substance not used by the jewellers—he did not know why, for it had many characters which might recommend it as superior to some which were used—the topaz. It broke very readily in one way; all that had to be done was to split it in that direction, and polish the surface, which was easily done. He had before him a large specimen, which he had so broken for the purpose of illustrating some of the characteristics of the Koh-i-Noor, a glass model of which lay before him, and looked as well as the diamond itself at the Crystal Palace, owing to that having been very roughly used. After the close of the Exhibition he had occasion to examine the stone, in consequence of some doubts which were thrown upon its authenticity. A statement was made that the East India Company had been imposed upon by the substitution of a stone of less value than the Koh-i-Noor. It was alleged that when seen by Tavernier, a French jeweller, 200 years ago, it weighed 279 carats; but when exhibited in Hyde Park in 1851, it only weighed 186 The shape when Tavernier saw it was very different from that which it had assumed in the Crystal Palace. Two years previous to its coming to England a paper was read at the British Association, in which it was shown that a piece was broken from it, and was then in Persia; and when exhibited here, it was minus of a piece like that stated to have been lost, and which if restored would make it as near as possible of the shape in which Tavernier saw it. A number of models of the Koh-i-Noor had been made; one by himself (Professor T.) of fluor-spar, a mineral which broke precisely in the same form as the diamond.

He had taken 6000 diamonds and sorted them,

and found that 4000 were in the form of octahedrons, and 2000 in the dodecahedron. Before going further with this part of the subject, he would point out another character of minerals—namely, *form*, and the right mode of studying it. The best lessons in geometry might be made by taking a bar of soap, and cutting it into half-a-dozen pieces, out of which they might shape them into geometrical forms.—[The lecturer here described the various figures.]—The octahedron was one form in which the diamond broke, and a piece of fluor-spar would break in precisely the same manner. Taking off the solid edges would make it into the form of a dodecahedron. A great secret in the art of cutting diamonds was a knowledge of the right part of the stone to break it in. At Amsterdam persons were employed in chipping the pieces from the corners of diamonds. Persons who used them for cutting glass knew that a particular angle would cut far more readily than another, and serve for a much longer time than others. By holding the front of the diamond at a particular angle, and drawing it along the glass, he could cut freely. The lapidary also knew that in cutting a stone one angle would take longer time in doing than another. So excessively hard was the Koh-i-Noor, that although the velocity of the cutting instrument was so great that the heat generated by the friction ignited the oil, causing it to take fire, yet they had only been enabled by such powerful means to cut one edge in double the time other parts of the stone took to grind down. The great point in cutting the diamond was to do so in the direction in which it would be broken; by that means a larger gem was gained than by any other method The lapidary knew that cutting it in a certain line would be best for a certain shape and purpose.

He had before him a model of what was supposed to be the best diamond known, one belonging to the French crown, as well as others belonging to Austria, Mr. Hope, and the Marquis of Westminster. He had also a model of the great Russian diamond, which he believed to be only a portion of the great Koh-i-Noor—which, when first discovered, weighed 793 carats; but when it came into the hands of Runjeet Sing it was reduced to 186 carats, and was now lowered to 102 carats, it having been greatly cut away for the purpose of getting rid of the flaws which previously diminished its brilliancy. In consequence of its brittleness it was cut instead of broken, which required great care to do, and which had been done as successfully as it could possibly have been under the circumstances.

Chemically, the diamond was carbon in its purest form. Its hardness was No. 10 in the list, and its specific quantity 3 decimal 5.

He had a diagram illustrating the mode of working for diamonds in Brazil, as described by the late Mr. Mawe, whose travels in that country created some sensation in the early part of the present century. They were searched for chiefly by slaves, who by practice became accustomed to their peculiar lustre and form. In a case upon the table there were specimens of the ordinary forms of diamonds in their crude state, and after they had come from the hands of the lapidary, and which were also selected for the purpose of showing the different colours. The pink and blue were very rare, the white more common, and the yellow still more so. Those which were full of flaws were sold under the technical term of "bort," at prices varying from 12*s*. to 20*s* a carat, but which were much adulterated by being mixed with other materials.

He was anxious that his auditory should understand clearly the *crystalline form* of the diamond. Sometimes white sapphires, and at others white spinels, were mixed with them. In distinguishing the stones, their crystalline form was the most important criterion they had to look to.

The *corundum* included several varieties of precious stone—the oriental ruby, topaz, amethyst, emerald, &c. They broke diagonally in the form of a rhomb. There was in the Museum of Paris one of the finest crystals, or broken fractures of the corundum that he knew of. In the British Museum there were also some very good specimens, illustrating the peculiar property of the stones he had referred to. One was a six-ray, belonging to the variety called star-stones; as it was moved about in different positions, the whole of the rays of light were reflected from the surface. In quality of hardness it was next to that of the diamond. A file would not touch any one of the substances below No. 6 in the list.

There were in the case before him specimens of quartz crystal of precisely the same description as that for which the Californian jeweller offered £200, and for which he (Professor T.) told the owner that 5*s*. would be a very fair price. In proof of that statement he referred him to several books upon the subject, and took a similar piece and broke it, showed him its similarity as regarded lustre and hardness, and that it would not scratch a piece of topaz, but that the topaz would scratch it; and reminded him of the fact that that which would yield to the other must be the softer of the two. A topaz could be readily scratched with a diamond. The next point was its specific gravity, the most decisive test of all; that of the crystal quartz was 2 decimal 6, whilst the diamond was 3 decimal 5. The gentleman was perfectly satisfied with the explanation, and begged his (Professor T.'s) acceptance of the supposed diamond, which was then on the table.

The *spinel ruby* was called in the trade the soft ruby, because it was soft as compared with others which were usually distinguished by their octahedral form, which however varied, as they could see by the specimens present One of them was called the macled crystal. They were usually distinguished by their hardness and form alone. An experienced eye could tell them by their peculiar lustre. A piece of quartz picked from the bed of a river, used for the purpose of polishing, was soon distinguished by the great difference in the hardness. One was No. 9 in the list of hardness; the spinel was No. 8. It belonged to the topaz class as regarded its hardness and specific gravity. In its composition the spinel ruby contains 69 parts of alumina, 26 magnesia, 3 protoxide of iron, and 3 silica.

The *sapphire* was the purest form of aluminium, the new metal which had lately created such interest, and which could be obtained in great quantities from that stone, although at too

great a cost commercially. Aluminium was obtained from a mineral called cryolite, which contained materials that enabled the chemist to extract it much more readily than from the sapphire. In works on mineralogy the sapphire was classed under the head of corundum. When blue it was called "sapphire;" when red, the "oriental ruby;" when yellow, the "oriental topaz;" when green, the "oriental emerald," and so on.

Passing over the topaz and the emerald, he should next come to the *beryl*, because it was a stone used by watchmakers. It was crystallized and a six-sided prism, some very fine specimens of which were on the table. Experienced persons could readily distinguish between the different specimens of this class. No doubt there were persons present who found in the course of their professional engagements that their statements were discredited by some incredulous individuals. He remembered a case in point. A gentleman showed him a stone, and asked him what he thought of it. He replied that there was nothing very particular in it. The gentleman rejoined, "It is very, evident you know nothing about it." He replied, "Perhaps so. What do you wish it to be." The gentleman said, "I wish it to be what it is." He (Professor T.) replied, "I confess my ignorance; I do not know what it is." The gentleman said, "It is beryl. How can you tell what it is when you have never taken it into your hands?" He could see what it was by its shape—it was a six-sided prism, very different from the beryl; but the gentleman left very much disappointed that he did not agree with him that it was that particular stone.

He held in his hand a specimen of the *crystal quartz*, brought from a montainous district in Switzerland, where they were very common. They were also found at Snowdon, but not so large They constituted what was called by lapidaries "pebbles." They were used for spectacle glasses, and were frequently mixed with some of the specimens used by jewellers. It was also used for jewelling the cheaper kind of watches. It was No 7 in the scale of hardness, and was readily scratched by other substances. On the surface of the quartz there were some fine lines called "striæ," which all run across the crystal. Beryl might be distinguished from quartz by being striated in the opposite direction. (Describing.) When broken, the quartz would be found to have a curved, and the beryl a straight fracture. Sometimes cracks in crystalline stones were caused by ill-usage; they were forced into barrels, which were filled up carelessly with sawdust. The expenditure of £1 in packing would often render the goods worth £20 more upon their arrival here.

Another stone used a good deal in watch-jewelling was the *chrysolite*, a substance only of the hardness of quartz, and which was easily worked.

The mode of *valuing diamonds*, when cut free from imperfections, was described by Jeffreys, who wrote a valuable treatise on jewels and precious stones during the latter part of the last century. It was estimated that a diamond of a carat in weight was worth £8; but one of two carats was worth £32, more than double; and that one of five carats weight was worth £200. The value was estimated in proportion to the square of the weight. Thus, to find out the price of a five carat stone, it was necessary to multiply 5 by 5, being 25, and to multiply that again by 8—the value in pounds sterling of the single carat—which would give the sum he had before named, viz., £200. Any person possessing a diamond of that weight, free from imperfections, would have no difficulty, under any circumstances, of getting £180 for it; and if he did not want the money, and waited, he would get the full £200 for it. That rule of calculation held good for stones of from 1 carat up to about 10. Diamonds of more than 10 carats weight were extremely difficult to get, although in proportion to their scarcity was their dearness; yet the small number of persons enabled to become their purchasers would possibly re-act, and reduce the value. A diamond of 100 carats weight—the Koh-i-Noor being 102—would be worth about £80,000, a little fortune shut up in a small casket.

He had there a drawing of a crown in the Tower, with a description of its jewels, which he intended to comment upon, but he would give it to the gentleman of the press near him, as he had tired their patience.

Having talked about what are the *precious minerals*, let us revert for a moment to some of a more common mercantile character. In this country there are no diamond mines, and very few of gold. In many cases gold mines in working have proved complete failures. Judiciously managed, they would pay 8 or 10 per cent. profit; but gold-seekers sought to realize large fortunes at once. In Wales he had seen gold in considerable quantities; but, in consequence of the hardness of the rock containing it, it would not pay more than 8 or 10 per cent. to get it; and even then with some risk. Another objection to such mining speculations was, that gold was a substance easily purloined by the workmen. One mining proprietor had told him that, out of 36 oz. obtained, the workmen had only returned him 7 oz. Then, again, the machinery of joint-stock companies in London took nearly all the gold from the gingerbread. What was the value of an ounce of coal? There was no coin sufficiently small to represent it. What was the value of an ounce of iron or lead? About the same proportion. Yet the coal and iron extracted from the earth was the mainstay of the commerce of England, and were far more important to it than any diamond mines. What was the value of 1 oz. of copper? Rather over 1*d*. What was the value of 1 oz. of silver? About 5*s*. 1*d* What of gold? About £4. The very refuse of diamonds was worth £60 an ounce. The finest diamond known weighed 136½ carats, a little under one ounce, and sold for £130,000. That scale showed the comparative value of those minerals; but their real utility to Englishmen, as a commercial people, was in the reverse ratio. The annual value of the coal and iron obtained from the Bristish isles amounted to twenty millions sterling.

Professor Tennant concluded his interesting and valuable Lecture amidst loud applause. A cordial vote of thanks having been passed to him, the proceedings terminated.

EFFECT OF MAGNETISM ON TIME-PIECES.

(*From the "Philosophical Magazine."*)

***On the Irregularity in the Rate of Going of Time-pieces occasioned by the Influence of Magnetism. An Original Communication, by* Mr. VARLEY.**

Having studied the theory of clock and watch-making many years, as well as having been, part of that time, concerned in an extensive manufactory of watches, I have had many opportunities of observing a circumstance which has surprised every one in the trade as well as myself,—that watches of considerable price, and from the hands of excellent workmen, often perform no better than a plain one of inferior workmanship and much lower price. Being anxious, as may naturally be supposed, to furnish my friends with watches or clocks which would go well, I made it my business to pay particular attention to whatever could contribute to their perfection. With this view I made almost numberless experiments and observations on the various escapements now in use, the different constructions of balances, pendulums, pendulum-springs, and compensations, both for clocks and watches, which have been applied by very ingenious mechanics and excellent workmen to correct the errors in the rate of going, especially of watches, occasioned by the various degrees of heat and cold, change of position, external agitation, influence of oil, friction, variation of maintaining power, and other causes.

Some of these contrivances are extremely well adapted to answer the intended purpose; but, notwithstanding all their advantages, the maker and purchaser are frequently disappointed in the performance of the machine to which they are applied. Many instances might be produced where the best workmen have been employed, no expence spared by the maker, and the above-mentioned improvements applied with the utmost care and attention, and yet the rate of going of the watch has been more irregular than in some ordinary watches. When such a circumstance occurs, it is extremely unpleasant; the purchaser, not understanding the difficulties which the maker has to encounter, thinks himself ill-used, and the latter suffers at the same time in his reputation as an artist, and in his character as a man; and when the watches happen to have been made for nautical purposes, or for exportation, the whole community, in some measure, become sufferers.

The intention of the present paper is to point out a defect in the construction of time-pieces of every description in which balances are used, and at the same time a source of error in their performance, which has been hitherto little if at all suspected, but which, where it occurs, completely defeats all the ends intended to be answered by the application of the above-mentioned ingenious contrivances; and that it does occur very frequently, will be made sufficiently obvious by a simple detail of facts supported by actual experiments.

That the balances of watches, when manufactured of steel, as they mostly are, might be in a small degree magnetic, and consequently have some influence in disturbing their vibrations, has been suspected by some and denied by others: but that a circular body, such as a balance is, should possess polarity; that a particular point in it should have so strong a tendency to the north, and an opposite point an equal tendency to the south, as to be sufficient materially to alter the rate of going of the machine when put in different positions, has never, I believe, been even suspected. If it had, the use of steel balances would have been laid aside long ago, particularly where accurate performance was indispensable, as in time-pieces for astronomical and nautical purposes. Though I have frequently examined with great care watches that did not perform well, even when no defect in their construction or finishing was apparent, and suspected the balance to be magnetic, yet I never could have imagined that this influence, operating as a cause, could produce so great an effect as I found upon actual experiment; for I did not expect to find that a balance, even when magnetic, should have distinct poles. Happening to have a watch in my possession, of excellent workmanship, but which performed the most irregularly of any watch I had ever seen, and having repeatedly examined every part with particular attention, without being able to discover any cause likely to produce such an effect, it put me upon examining whether the balance might not be magnetic enough to produce the irregularity observed in its rate of going.

I took the balance out of its situation in the watch, and, after removing the pendulum spring, put it into a poising tool, intending to approach it with a magnet, but at a considerable distance, to observe the effect, while at the same time the distance of the magnet should preclude the possibility of the magnetic virtue being thereby communicated to the balance. I had no sooner put it into the tool than I observed it much out of poise, that is, the one side appeared to be heavier than the other; but, as it had been before examined in that particular by a very careful workman, more than once, I was at a loss to determine

what to think of the effect I saw; when happening to change the position of the tool upon the board, the balance then appeared to be in poise. As there could be no magic in the case, it appeared that the balance had magnetic polarity, as no other cause could produce the effect I had witnessed, and which was repeated as often as I chose to move the tool from the one position to the other. It happened that I was then sitting with my face to the south; a circumstance that led me, in placing the plain of the balance vertically, to put it north and south, and of course the axis east and west—the only position in which the magnetic influence could make itself most apparent, and which will account for the circumstance not having been observed by the workman who examined the poise of the balance before I did; for, as often as I placed the plain of the balance vertically between east and west it was in poise, whichever end of its axis was placed towards the south.

Having pretty well satisfied myself as to the cause, I now proceeded to determine the poles of the balance. With that view I placed its axis in a vertical situation, and of course its plane was horizontal; and I was much surprised to find that in that position it possessed sufficient polarity to overcome the friction upon its pivot, for it readily turned on its axis to place its north pole towards the north. Making a mark on that side that I might know its north pole, I then repeatedly turned that point towards the south; and, when left at liberty, it as often resumed its former position, performing a few vibrations before it quite settled itself in its situation and came to rest—exactly as a needle would do if suspended in the same manner.

I was extremely happy that I had observed these effects before I brought a magnet to make the experiment I first intended, as I might, and as others also might have concluded, that the polarity had been produced by the approach of the magnet. I now, however, brought a magnet into the shop, and, presenting its south pole to the marked side, that is, to the north pole of the balance, the balance continued at rest; but upon presenting the north pole to the marked place, it immediately receded from the magnet, and resumed its former position whenever the magnet was withdrawn.

No doubt now remaining as to the facts, and being in possession of the position of its poles, I proceeded to examine the effects produced by this cause upon the watch's rate of going. Having put on the pendulum spring, and replaced the balance in the watch, I laid the watch with the dial upwards, that is, with the plane of the balance horizontally, and in such a position that the balance when at its place of rest should have its marked side toward the north:—in this situation it gained 5′ 35″ in twenty-four hours. I then changed its position so that the marked side of the balance when at rest should be towards the south, and, observing its rate of going for the next twenty-four hours, found it had lost 6′ 48″—producing, by its change of position only, a difference of 12′ 23″ in the rate. It must be obvious to every person, that even this difference, great as it was, would be increased or diminished as the wearer should happen to carry in his waistcoat pocket a key, a knife, or other article made of steel. This circumstance, taken along with the amount of the variation occasioned by the polarity of the balance, was fully sufficient to produce all the irregularity observed in the going of the watch.

I then took away the steel balance, substituted one made of gold, and found it as uniform as any watch of the like construction; for, though it was a duplex escapement, which is perhaps the best yet invented, at least for common purposes, it had no compensation for the expansion and contraction occasioned by heat and cold, and therefore a perfect performance was not expected.

Steel balances being commonly in use, and on that account easiest to be procured, and being on many accounts preferable to any other, I was unwilling to abandon them entirely; but resolved to take the precaution of always trying them before I should apply them to use. The mode I adopted was, to lay them upon a slice of cork sufficient to make them float upon water, and I was in hopes that out of a considerable number I might be able to select sufficient for my purpose; but, to my surprise, out of many dozens which I tried in this manner, I could not select one that had not polarity. Some of them had it but in a weak degree, and not more than one or two out of the whole quantity appeared to have it so strong as the one which gave birth to these experiments and to the present paper, which is perhaps more prolix than could be wished; but the subject appeared to be not uninteresting, and I hope the remarks I have offered will not be altogether useless, as every thing that can tend to add to the perfection of time-pieces, or to remove any cause that operates against their perfection, is of some importance.

My only motive in sending this for publication is to render some service to a science which I at first studied for amusement only, having never been instructed in any part of it, aud for some years without the most distant idea of ever following it as a business.

is principally to remedy the irregularities of the motive power in watches which go several days without being re-wound. The details of the mechanism cannot be well understood without models or engravings of the different parts. In the absence of these, let us endeavour to explain the principle upon which rests the whole of the construction, and the effects it is designed to produce.

A spring inclosed in a barrel, when wound up, produces two forces, or rather a power which acts by the teeth of the barrel, and a resistance which results from the abutment of the ratchet of the barrel arbor against the click of arrest. The sum of this power and

CHRONOMETERS FOR THE ROYAL NAVY.—In the House of Commons, in committee on the Naval Estimates (17th April), Lord C. Paget stated, in reply to a question from Admiral Walcott, that there would be no objection to allowing officers who had retired from the service the value of their chronometers, as determined by the Astronomer Royal. The Board of Admiralty had framed an order—to which he trusted they would soon obtain the sanction of the House—for granting three chronometers to line-of-battle ships, frigates, or troop ships, two chronometers to sloops, and one to gun-boats. It was only fair that officers should be relieved from the expense of providing their own chronometers.

ACCELERATION ON THEIR RATES OF NEW CHRONOMETERS;—

THE CAUSE, AND HOW TO PREVENT IT.

To the Editor of the Horological Journal.

Sir,—It has been stated in the *Horological Journal* by several chronometer makers, that pendulum springs by being hardened, or by having their ends bent with a pair of bending pliers, acquire the property of getting stronger after having been for some time in action; and this has been assigned as the cause of new chronometers gaining on their rates. I have several times read what your correspondents have written about it, but am sorry to say I am not able to understand the way in which those gentlemen are reasoning, or how a spring can get stronger by the particles in the steel accommodating themselves to one another.

Having myself been a good deal engaged with the springing and timing of chronometers, I have often noticed the tendency to accelerate; and, if I may be allowed, I will state what I consider the cause of it, and how it perhaps may be prevented, without having recourse to the uncertain remedy of making the pendulum spring so soft that it constantly loses of its original strength.

The unlocking of the detent retards the vibration of the balance, and that it is not in a slight degree can be seen by the great alteration it makes in the rate of a chronometer if the unlocking spring is made a shade longer or shorter. If the spring is made longer, the chronometer goes slower; and if it is made shorter, it gains on its former rate. As the unlocking pallet rubs on the end of the unlocking spring 345,600 times in every twenty-four hours, it is natural to suppose that a small matter of the spring is after some time rubbed off or burnished down; as we also often find a slight indentation in the gold spring, in the place where it falls against the end of the detent. From this cause the detent is, after some time, not lifted quite so far out from the wheel as when the chronometer is first set going; and when to this is added that the scape-wheel teeth, which for safe locking and proper impulse are but little rounded, and sometimes left with sharp edges, by degrees become a little more rounded and shortened, we see that the unlocking by degrees becomes easier, and that the chronometer from that cause must accelerate, till the acting parts of the escapement become burnished down, or the oil gets sufficiently thick to produce a compensation, when it will for some time keep a pretty settled rate.

If the unlocking spring were made of hardened and tempered steel instead of gold, and the end of it left as hard as possible without danger of snapping off, it would better stand the blows of the unlocking pallet. But it would then be necessary to put the least quantity of oil on the unlocking pallet, as the spring otherwise would wear itself away in rust. A little oil applied to the unlocking pallet will produce no injurious effect; but great care must be taken that no oil gets on the end of the detent, as it would make the unlocking spring stick, whereby the vibration of the balance would fall off; and it would therefore be better to make the unlocking end of the detent a little shorter than what is usually done. The locking pallet might also lean a little back towards the foot of the detent, whereby a fresh part of the teeth would gradually get into use. The greatest care must of course be taken that the scape-wheel and unlocking spring are as hard as possible, and that no sharp edges are left on any of the acting parts. Great attention must also be paid to the pallets; and they ought to be so firmly set that even the melting of the shellac would not allow them to move. I believe if this be done, a chronometer will not accelerate; as it seems clear that the acceleration arises from a decrease in the resistance the balance has to overcome in the unlocking of the detent.

That a soft spring loses more of its strength than one that is hardened is certain; but that any spring should, in the same temperature, actually get stronger by having been for some time in action, I consider to be quite a mistake. Your's respectfully,

F. KNUDSEN.

33, Cockspur-street, Charing-cross.

DOUBLE FLAT BALANCE SPRINGS.

To the Editor of the Horological Journal.

Sir,—I have only one or two observations to make in reply to Mr. Cole's letter in the 20th number of your Journal.

Mr. Cole refers to his remarks in your 15th number on the Double Volute Spring; they are as follows:—

"I have taken the opportunity of applying a tempered pendulum spring, as an illustration of the double volute, with close attachments at the stud and collet, intended for lessening the excentric force of the spring, and consequently the position errors of the watch."

I can conscientiously assert that these (not very definite) remarks afford no index to the principle on which my invention is based.

The mode of making Mr. Cole's "Double Volute Springs," as described in his letter of the 14th March, is necessarily uncertain and liable to error.

My double flat springs are manufactured by machinery, and can be made of equal or unequal number of coils in the upper and lower spirals, and without any uncertainty or risk of failure.

So far from the idea having originated in the quoted remarks of Mr. Cole, I exhibited my springs more than two years since in London to Messrs. Connell, Abbot, Pool, and others, and though many improvements have since been made in them, the principle is the same as then exhibited.

I am, Sir, your's respectfully,

J. Hammersley.

P. S.—Should any one doubt that the acceleration of rate in new chronometers is caused by the bending of the balance spring after it is finished, they may easily satisfy themselves on that point by re-bending the spring of a chronometer which has settled to a rate, and they will find that the chronometer will accelerate on its rate as at first.—J. H.

HISTORICAL GLEANINGS

RELATING TO CLOCKS AND WATCHES.

Near six centuries ago, in the sixteenth year of the reign of Edward I., A. D. 1288, the earliest clock in London of which we have any authentic account was erected. Its origin affords a proof how strong was the desire, thus early in our history, that justice should be dealt with an even hand, although the fault in this case was having leant to mercy's side. The Hon Daines Barrington states,* that "the Lord Chief Justice Radulphus de Hengham having made an alteration in a record, by which a poor defendant had to pay six shillings and eight-pence instead of thirteen shillings and four-pence, a fine of 800 marks was inflicted upon him by the King's order, and the money was applied to defray the cost of erecting a public clock opposite the entrance to Westminster Hall." No details of its construction have come down to us, but, from Stowe's "Account of Westminster," we find that this clock was considered during the reign of Henry VI. to be of such importance that the king gave the keeping of it to William Warby, dean of St. Stephen's, with the pay of sixpence per day, to be received at the Exchequer. The date of its removal is uncertain; but that it remained till the time of Elizabeth is evident by Judge Southcote mentioning the tradition, and stating that the clock still remained which had been made out of the Chief Justice's fine. The dial on the second pediment of the buildings in Palace-Yard marks the site; the remarkable motto on which, "*Discite Justitiam Moniti*," clearly relates to its origin. The clock in the tower of the New Palace at Westminster, intended by its promoters to be an unequalled specimen of horological art in the 19th century, stands but a short distance from the spot once occupied by this early monitor of Time's flight.

* Archæologia, vol. v.

From an allusion made by Dante, we learn, that striking clocks were in use in Italy in the 13th century. That they were not uncommon in England in Chaucer's time, is evident from his lines alluding to the crowing of the cock. Chaucer was born in 1328, and died in 1400.

In France, in 1332, according to Froissart, Philip the Hardy removed from Courtray to Dijon a clock which struck the hours and was remarkable for its mechanism.

Portable time-measurers, or watches, were not common until the latter end of Queen Elizabeth's reign, although first introduced in Henry VIII.'s time. They were made in various forms—many oval, the cases generally being highly ornamented,* it having become the fashion to wear them as personal ornaments.

In the third year of James I. a watch was found upon Guy Fawkes, which he and Percy had bought the day before to try conclusions for the long and short burning of the touchwood they had prepared to fire the powder.

In 1631 the Clockmakers' Company was incorporated, and from the charter prohibiting the importation of clocks, watches, and alarums it is evident there was a numerous body of artists in this country expert at the business.

Among royal patrons of the art, Charles II. and James II. may be included. Of the former monarch it is related, that watchmakers used to attend him whilst playing at the Mall; a watch being often the stake. From this time the progress was rapid, the genius of Hooke and Huyghens having converted what was formerly but an expensive toy into an accurate time-measurer. Although Hooke

* See *Horological Journal*, No. 17, January, 1860.

4. To the locker, which is a cylindrical piece of steel, one end being smaller than the other, and projecting through a hole in the rim of the case, the larger end acting between two pins on the plate. A spring passes over it down, and at the against the

5. has two pins, one of which steel on the arbor of the fly alarum from running down; the other is worked on by the small end and is called the tail, and is for the purpose of discharging the alarum.

The action of the above machinery is as follows:—When the detent spring is elevated, it presses down of the in its turn presses and thus presses the circular head outwards, and causes the small end of the locker When the pin of the detent and alarum.

[Printed, 6*d.* Arts, vol. 5 (*third series*), p. 67; London Journal (*Newton's*), vol 2 (*second series*), p. 84; Register of Arts and Sciences, vol. 1 (*new series*), p. 128; and Engineers' and Mechanics' Encyclopædia, vol. 1, p 700.]

1827, December 13.—No. 5586.

BERROLLAS, JOSEPH ANTHONY.—1. The barrel ratchet, with its click and spring, which keeps the maintaining power up, is put on

fastened other end is passed through impendent. The chain is not longer than to produce one revolution of the pulley To wind up the impendent as far out as possible; the will carry it operation must be repeated until Similar

2 A finger kind of cap with a "milled edge; the minute hand is fastened to it when "

in No. 5489, is made to remain in the case when it formerly protruded, and vice versâ, by the fulcrum of the propeller being side of the inclined plane. The is superseded, and a spring put on the motion received by the tail of the is a straight and not a side motion as formerly.

[Printed, 6*d.* See Repertory of Arts, vol. 8 (*third series*), p. 1; London Journal (*Newton's*), vol. 4 (*second series*), p. 78; vol. 9, p. 65; Register of vol. 2 (*new series*), p 4; and Mechanics' Encyclopædia, vol. 1, pp. 698 and 702]

(*To be continued.*)

EQUATION OF TIME TABLE

For May, 1860.

Day of the Week	Day of Mnth	At Apparent Noon — Equation of Time to be *subtracted* from Apparent Time.	Difference for One Hour.	At Mean Noon — Equation of Time to be *added* to Mean Time.
		m. s.	s.	m. s.
Tues..	1	3 5·14	0.298	3 5·16
Wed..	2	3 12·29	0·276	3 12·30
Thurs.	3	3 18·89	0·253	3 18·90
Fri. ..	4	3 24·95	0·230	3 24·97
Sat. ..	5	3 30·45	0·206	3 30·46
Sun. ..	6	3 35·40	0·182	3 35·41
Mon...	7	3 39·77	0·158	3 39·78
Tues..	8	3 43·56	0·134	3 43·57
Wed..	9	3 46·77	0·110	3 46·78
Thurs.	10	3 49·40	0·085	3 49·41
Fri. ..	11	3 51·43	0·060	3 51·43
Sat. ..	12	3 52·87	0·035	3 52·87
Sun. ..	13	3 53·71	0·010	3 53·71
Mon...	14	3 53·95	0·015	3 53·95
Tues..	15	3 53·60	0·039	3 53·60
Wed..	16	3 52·67	0·063	3 52·67
Thurs.	17	3 51·15	0·087	3 51·15
Fri....	18	3 49·08	0·110	3 49·07
Sat. ..	19	3 46·43	0·133	3 46·42
Sun. ..	20	3 43·23	0·156	3 43·22
Mon...	21	3 39·49	0·178	3 39·48
Tues..	22	3 35·22	0·200	3 35·21
Wed..	23	3 30·43	0·220	3 30·42
Thurs.	24	3 25·14	0·240	3 25·13
Fri. ..	25	3 19·37	0·260	3 19·35
Sat. ..	26	3 13·12	0·279	3 13·11
Sun. ..	27	3 6·42	0·298	3 6·40
Mon...	28	2 59·25	0·317	2 59·23
Tues..	29	2 51·65	0·334	2 51·63
Wed..	30	2 43·62	0·351	2 43·60
Thurs.	31	2 35·19	0·368	2 35·18

London B by R. MACDONALD, 30,

THE BRITISH HOROLOGICAL INSTITUTE.

THE HALF-YEARLY MEETING of the Members will be held at the Institute, 35, Northampton Square, on Thursday the 21st of June, — To receive the Report of the Half-year ending on the 15th instant, and the Balance Sheet; also for the Election of the following Officers: President, Vice-Presidents, one Trustee, Treasurer, Honorary Secretary, and Members of Council in room of the retiring Members, who are all eligible for re-election, and to fill up any other vacancies that may occur.

All Nominations and Notices to be addressed to the Honorary Secretary on or before the 7th instant.

By order of the Council,

1st June, 1860. GEORGE E. MYLNE, *Honorary Secretary.*

INFLUENCE OF MAGNETISM ON TIME-PIECES.

On a Remarkable Case of Magnetic Intensity of a Chronometer. By GEORGE HARVEY, Esq., M.G.S, M.A.S., &c.

A box chronometer having lately come into my possession, exhibiting remarkable proofs of strong and active magnetism, I was induced to examine it particularly, and to ascertain the intensities of its different parts, by means of an apparatus resembling that employed by Coulomb, and which was capable, from its very delicate construction, of indicating the existence of the minutest traces of attraction.

By denoting the power of the terrestrial magnetism by 100, the intensity of the chronometer, one inch above the centre of its crystal, was only 90·79, when the hour of XII pointed to the north; but, on turning the time-keeper, so as to bring IX into the same direction, the intensity was augmented to 102·29, the position of the oscillating cylinder remaining unchanged; and by again turning it another quadrant, so as to bring VI to the north, the intensity again declined to 90·69, corresponding very nearly with the result determined in the first position; and, lastly, when III was brought into the same situation, the measure of the intensity farther declined to 78·89: So that the attraction was a maximum when IX was directed to the north, and a minimum when III was brought into the same situation; and, what is further remarkable, the nearly equal intensities corresponding to the positions of XII and VI, approach very closely to a state of equality with the mean of the maximum and minimum intensities. The results, however, may be more conveniently examined in a Table.

North.	Intensity.
XII	90·79
IX	102·29
VI	90·69
III	78·89
Mean	90·66

When these conclusions were obtained, the chronometer had not been in motion for some months. The time at which it stopped being $9^h\ 7^m\ 50^s$, will of course determine the respective positions of the hour, minute, and seconds hands with respect to the oscillating bar, or the magnetic meridian. These particulars became necessary to be attended to, in consequence of the strong polarities of the three hands.

In two subsequent experiments, XII being directed to the north, the intensity at three inches above the crystal was 94·70, and at five inches 97·42.

Finding that such remarkable changes of intensity resulted from merely turning the chronometer, similar experiments were performed at the same distance above the middle of the bottom of the box, and the results of which are recorded in the following table:

North.	Intensity.
XII	77·17
IX	91·34
VI	101·26
III	94·94
Mean	91·18

and from which it appears, that the maximum intensity was found when VI pointed to the north, and the minimum when XII was in

the same situation; and that the mean of the four intensities approaches very nearly to an equality with that entered in the former table.

The top and bottom of the chronometer presenting so many varieties of attraction, it was conceived that similar anomalies might result from an examination of its sides. Accordingly, when XII was uppermost, and the oscillating cylinder one inch above the middle of the side, the intensity amounted to 105•61; but when the time-keeper was turned, so as to bring IX below the cylinder, the measure of the attraction rapidly declined to 89·61; and when VI was examined, it increased to 91•78; and, lastly, when III pointed upwards, it again declined to 84•05. These results may be conveniently arranged in a table.

Side of the Chronometer uppermost.	Intensity.
XII	105•61
IX	89•61
VI	91•78
III	84•05
Mean	92•76

The preceding observations having been made on the external parts of the chronometer, the intensity of its internal works was next determined; and, first, by placing the centre of the oscillating cylinder one inch above the extremity of the steel arbor of the fusee, which possessed magnetism in a very high degree, when the intensity was found to be 109•09; but when the measure of the attraction was ascertained, in the line of a common tangent, proceeding from between the barrel and fusee, XII being uppermost, it declined to 107•82. A still greater declension was, however, remarked when the chronometer was turned another quadrant, so as to bring the middle of the side of the spring box an inch below the centre of the oscillating bar, IX being upwards, the intensity amounting only to 92•22; the north pole, at the same time, dipping three degrees. Three coils of the steel-chain were wound round the box. The time-keeper being afterwards moved through a third quadrant, so as to bring the cylinder over the spring of the balance, VI being uppermost, the north pole dipped two degrees, and the intensity amounted to 101•26. And lastly, by turning the chronometer through a similar portion of a circle, bringing III upwards, and by this means placing the centre of the oscillating cylinder over the small interval between the balance and the fusee, the intensity fell to 79•51. Below the cylinder, in this case, *were* the arbor of the fusee, and a ratchet and pivot for the same, all of steel, and possessing considerable magnetic power. These results are arranged in the following table:

Side of the Chronometer uppermost.	Intensity.
XII	107•82
IX	92•22
VI	101•26
III	79•51
Mean	95•20

These conclusions bear some analogy, as indeed they ought, to those recorded in the preceding table, the maximum intensity corresponding in each case to the position XII, and the minimum to that of III. The positions denoted by VI and IX are also in both cases next to the maximum in point of magnitude.

The magnetism of the balance and its spring were also powerfully displayed, by raising the chronometer when VI was uppermost, so as to bring the circumference of the latter within an inch and a quarter of the oscillating cylinder; the dip being increased from two to five degrees, and the intensity diminished from 101•26 to 95•99.

On examining the balance, the inner rims of the arcs of compensation were found to be of steel, and so likewise were the time-screws, which connected them with the transverse arm. These parts were in a state of active magnetism, particularly the time-screws, one having strong northern polarity, and the other southern. The small wormed cylinders also, on which the thermometer pieces moved, presented equal proofs of polarity, one being a north pole, and the other a south. The time-screw and thermometer piece having northern polarity were on one side of the balance, and those having southern on the other. The balance-spring likewise exhibited vigorous polarity.

When the north pole of a small bar magnet was placed near the extremity of the wormed cylinder which possessed northern polarity, the balance immediately receded a small quantity; but when the south pole was applied, the power was sufficient to cause it to advance through a minute but sensible arc; and similar effects were produced when the proper poles of the magnet were presented to the extremity of the wormed cylinder having southern polarity. On presenting a more powerful magnet, the balance was drawn more than a quadrant from its quiescent position, and motion communicated to the chronometer.

By placing the time-screws in the direction of the magnetic meridian, and bringing the north pole of a pocket-compass near that

which possessed southern polarity, no deviation was of course perceptible in the compass-needle; but when the balance was moved through the arcs recorded in the first column of the following table, the deviation in the direction of the compass amounted to the quantities entered in the second; the inertia of the needle being too considerable to admit of its inversion. By employing a needle of a more delicate construction, an inversion of its poles took place, the moment the time-screw had passed through an arc of 90°, when a deviation of the south pole immediately followed.

Degrees of the Arc of Compensation.	Deviation of the Compass Needle.
0°	0°
10	4½
20	8½
30	12
40	15½
50	19
60	25
70	30
80	36½
90	43½
100	49½
110	54½

When the chronometer was so placed that the transverse arm which bears the time-screws of the balance became east and west, a fine compass-needle having its centre over the middle of the balance immediately disposed itself in the same direction, its north pole reposing over the screw which possessed southern polarity. When also the balance was turned through an arc of 90°, the needle turned with it, the north pole in consequence pointing to the south. The moment, however, the balance was allowed to vibrate, the needle commenced its oscillations, vibrating in progressively decreasing arcs, from the first semicircle described by it, to zero in the magnetic meridian, where it maintained a small tremulous motion. In another experiment, when the balance was turned through a greater arc than a quadrant before motion was communicated to the chronometer, the needle was nearly inverted, the north pole pointing west; and on motion being given to the balance, the needle ranged for many seconds through the complete circumference, until the directive power of the earth, by gaining the ascendancy, caused the arcs of vibration successively to diminish, the needle ultimately obtaining a position coincident with the meridian, where it continued in a state of tremulous motion as before.

The quantity of steel contained in this chronometer was truly remarkable, and no part of it was destitute of vigorous polarity. Every screw displayed its influence, and of which there were ten large, and several small ones, in the frame alone. The chain also, the axles of the different wheels and pinions, the arbor of the fusee, the balance and its spring, exhibited the same intense and active power.* Nor did this polarity partake of the transient character of that imparted by induction from the earth to soft iron, but was permanent, undergoing no sensible alteration from change of position.

From the short time the chronometer has been in my possession, no satisfactory account has been obtained of its rate. During the three preceding years it was constantly on ship-board, and its general character is said to have been good; although, at times, it appears to have been subject to rather more than ordinary aberrations. It would be interesting if a few facts connected with its previous history could be obtained, as they might probably throw some light on the source from whence it derived its active magnetic powers. At a future time, I hope to be able to communicate something on this head.

On a subsequent occasion, another chronometer was examined by means of the same apparatus. The balance evinced no proofs of polarity when small magnets were presented to it; but the apparatus of Coulomb detected some minute varieties of attraction in different parts.

By placing the oscillating bar three quarters of an inch above the centre of the glass-crystal, the magnetic intensity was found to be 94·36; and at the same distance above the centre of the bottom of the brass-case, it amounted to 100·63. When the chronometer was turned so as to bring its side below the bar, III being upwards, the intensity was 98·51; and on determining it on the opposite side, or when IX was uppermost, it amounted to 94·02. When the cover of the chronometer box was closed, and the intensity determined at the before-mentioned distance above its middle, the measure of the attraction became 99·13. The intensity therefore was the greatest near the bottom of the brass case.

This chronometer appeared to have been constructed with every possible care to avoid the introduction of magnetism. The handles of the box, the hinges and screws, the lock, staples and key, were all of brass; still, from

* Mr. Cox, the agent for Arnold's chronometers at this place, and whose accurate knowledge of the principles and action of time-keepers is so well known to many of the most distinguished officers of his Majesty's Navy, remarked, when the chronometer under consideration was shewn to him, that it appeared nothing less than a *Magazine of Magnets*.

the anomalous results above presented, the variations of intensity were more considerable than could have been anticipated, considering the very small quantity of steel that appeared in it. These variations are indeed inconsiderable when compared with the changes of intensity exhibited in the former instance; but are sufficient to prove that magnetism exists in chronometers, when, from the precautions employed in their construction, we should have imagined it altogether removed.

That the application of magnets to chronometers does not in all cases communicate magnetic qualities of a very powerful kind, may be inferred from the example of another chronometer, which had been frequently employed in inquiries connected with magnetism for many months, and which was subsequently examined by the apparatus of Coulomb. The oscillating cylinder was placed one inch above the crystal, and the intensity determined in four positions of the time-keeper, namely, when its XII o'clock mark was directed successively to the four cardinal points of the horizon; the experiment agreeing in this particular with one determined for the first chronometer. The following table contains the results:—

North.	Intensity.
XII	100·13
IX	99·75
VI	97·54
III	98·03
Mean	98·96

and from which it appears, that the mean of the four intensities approach very nearly to the assumed terrestrial intensity, and that, moreover, a much greater uniformity exists among the results than in those determined for the first chronometer.

The examples that have been furnished by Messrs. Varley, Fisher, Barlow, and Captain Scoresby, relative to the magnetism of chronometers, and from many experiments I have had an opportunity of performing, and a detailed account of which I hope soon to draw up, induce me to believe, that nothing short of the absolute removal of every thing capable of retaining the magnetic influence in the balance will prove an effectual remedy for the errors to which the rates of chronometers are liable from this cause. Captain Scoresby, in an excellent paper published in the 9th volume of the Edinburgh Transactions, proposes, with his usual ingenuity, to free the balance from any magnetism it may have acquired, by causing it to be ground and polished in the plane of the magnetic equator; or, as they are now generally constructed of soft steel, to have them *turned* in that plane. This method of obviating their anomalous action would in all probability be effectual, if similar precautions could be taken with the steel employed in the other parts of a chronometer. But the chain alone would be capable of imparting, in a short time, any magnetic qualities it might possess to the balance, and thus to restore to it that power of derangement which had been previously removed. Suppose, for example, that the balance of the first chronometer alluded to in this paper were to have its magnetism removed by the ingenious method recommended by Captain Scoresby, or by any other, is it not probable that the same property would be again acquired, from the active magnetism possessed by the numerous screws, the arbor of the fusee, the chain, &c., in consequence of the balance either remaining quiescent, or incessantly performing its vibrations in the neighbourhood of that which may, without impropriety, be denominated a System of Magnets? On the whole, therefore, the employment of a substance in the construction of the balance, not only without magnetism, but without the capability of acquiring it, will be the only effectual and perfect remedy for the anomaly in question. Platina, or an alloy of platina, has been mentioned by the intelligent and active philosopher last alluded to; and it is not improbable, but that it may be ultimately found as well adapted to the purposes of compensation as steel. Similar precautions are necessary in the formation of the balance-spring. Gold, it is said, is very well adapted for this purpose.

Plymouth, August 12, 1823.

NON-RESISTENT COMPENSATION BALANCES.

To the Editor of the Horological Journal.

Sir,—I beg to submit for your consideration the enclosed diagrams and descriptive papers, referring to a correspondence between Mr. S. Long and myself relating to Compensation Balances for Timekeepers, and to request that, in case the subject be approved, this communication may be inserted in No. 22 of the Journal.

I am, Sir, your's respectfully,
JAMES F. COLE.

29, Devonshire-street, Queen's-square, W.C.
12th May, 1860.

Fig. 1.

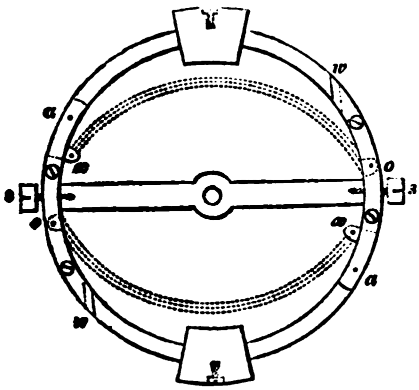
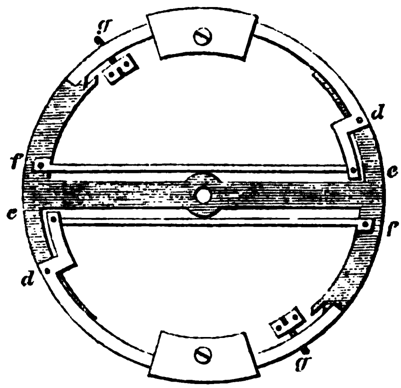


Fig. 2.



From Mr. S. LONG *to* Mr. J. F. COLE, *with Diagram* Fig. 1.

"London-street, Kingston-on-Thames,
"January 23, 1860.

"Sir,—Enclosed is a diagram of my Compensation Balance which I composed some years ago,* and I know that it performed more accurately than the common Compensation Balance, now and for so long a time in use; its expansion and contraction are more equal in all climates, as I have abundantly proved by experience, afloat and ashore. I shall now endeavour to explain it.

"The cross arm and rim are of platinum, as are also the compensation weights; the dotted lines are of brass. At each end of the rim, at *a a*, is a joint, on which each half of the rim works freely, and is retained in that place by a pin or screw as a centre of motion; thus it would carry the weights on towards the centre, or the reverse. The dotted lines are laminæ of brass firmly fixed to the arms at *o o*, and attached to the moveable rim at *x x*, the free end of the rim being guarded by any convenient means, as at *w w*, in Fig. 1. *s s* are the time screws. Of course you can see, the joint pin being at *a*, and the expanding brass being attached to the rim at *x*, it must push that short end of the rim outwards, carrying the longer end of the rim and weight inwards; and also that the nearer the end of the brass is carried in towards the joint at *a*, the greater will be the effect of the expansion and contraction of the brass.

"The requisites of a compound balance are, extreme sensibility to thermal changes, and regularity of rate of expansion in all climates; these properties my balance possesses. I am not aware that any other person has ever made use of the same adaptation but myself; and if you wish to have a model, let me know, and I will forward one. Your's, respectfully,

"S. LONG"

* In one of Mr. Long's letters he mentions the loss of his ship, with the chronometer having his improved balance, as having occurred in 1832.

From Mr. J. F. COLE *to* Mr. S. LONG, *with Diagram* Fig. 2.

"Sir,—I have just received your two letters, and am induced to answer the one describing your Compensation Balance immediately, being agreeably surprised to find the principle and general features of your plan to agree very nearly with a balance constructed by myself some years ago, as you will see by the enclosed rough sketch, bearing date 1842; the construction is as follows.

"The arm and two quarters of the rim is to be of platinum, made somewhat agreeing in form to the shaded part of the diagram Fig. 2, of entirely flat plate hard rolled; those portions of the rim which carry the weights are made from a hoop-formed ring of hard brass, and the weights were to be of platinum also; the jointed ends of the segments being divided in the manner of a fork, so as to fit just freely over the thickness of the platinum arm plate. Through the forks and arms at *d d*, are correctly-drilled perpendicular holes for the insertion of hard gold pins as centres of motion, the free ends of the limbs being guarded by double notched fittings without contact, so as to bear handling without any liability to injury. The forked ends of the pair of lever limbs are connected, at a suitable distance from the former centres, by pinning each as a lever tail to the free end *e, e,* of a linear expansion bar made of silver, brass, or zinc, the root ends of the expansion bars being immovably pinned through the thickness of the platinum arm plate at *f f*. The action will of course be manifest to you, as the only difference is in my using the principle of direct linear expansion by a straight single bar to each limb, instead of a laminated combination of thin plates as curved expansion bars; *g g* are the mean time screws.

"At the back of the enclosed Diagram paper is the ascertained relative expansibility of the metals I intended to employ: 'Thus:—1,000,000 parts of platinum expand, between the freezing and boiling points of temperature, 856 of those parts; steel, 1189; brass, 1783; silver, 1890.'

The observations apply equally to both balances described in the above correspondence:—

"The resistance of the ordinary Compensation Balance rim I supposed might operate in producing the error of extreme temperatures; but, apart from the question of compensation for temperature, I am of opinion that the adhesion of the united surfaces of the brass and steel, forming the laminæ of ordinary compensation balances, becomes less and less resistent by the action arising from differential expansion of the metals. The surfaces being united by fusion of the brass upon the steel leaves no space whatever between them; the tendency therefore, under so mathematically nice a condition of the surfaces in contact, of any action such as must necessarily arise from every change of temperature, will be to *partially* destroy the solidity or primary completeness of the molecular union, and eventually to produce less rigidity in the laminæ of the balance rim, which being from this cause at liberty to act with greater freedom would be more under the influence of temperature. This action, producing a gaining effect (as explained below), would in the course of time subside, as is indicated by chronometers generally attaining to a settled rate.

"The rim being at liberty to act with greater effect by change of temperature, and admitting that the expansion and contraction by equal increments of heat or cold will produce equal increments of motion in the weights on either side of a fixed point of temperature, it follows, that the effective action of the rim and weight will be greater by accession of heat when moving towards the centre of the balance, than when moved outward from the same fixed point an equal quantity by an equal accession of cold. This argument is based on the established law of the balance and the known effect of moving the mean-time screws an equal number of turns in or out from the exact mean-time position; the effect, though small by motion of the screws alone, is of course greater in proportion as the *entire* weight of the balance is governed by the action of the rim. The same law applies to the pendulum, in which if the rod be shortened one inch the difference of effect will be as about 1 to 25, but if lengthened one inch, as about 1 to 29 for a seconds pendulum. Equal turns of the nut operate in the same way.

"Hence I am led to consider that the possible disintegration of the particles uniting the brass and steel may be the entire or partial cause of acceleration of rate in all timekeepers with ordinary compensation balances. I am further of opinion, that this theoretical view of the cause of acceleration of rate admits of being tested, and by no better means than by trial and result of the non-resisting compensation balances herein described, and in which no steel is employed; they are therefore completely non-magnetic."

J. F. C.

DESCRIPTION OF A TABLE CLOCK MADE BY BENJAMIN MARTIN, A.D. 1770.

With an Illustration of a Cycloidal Arc.

Fig. II.

Fig. III.

Fig. I.

Description of a Table-Clock *going Eight days, by a* weight, *with a Half-seconds Pendulum of* invariable length, *and thereby dividing Time into Hours, Minutes, and Half-seconds. By* Benjamin Martin. 1770.

It is presumed that every one who pretends to any skill in clock-work, must necessarily know, that all the truth of such time-pieces depends upon and results from the three following general principles :—

1. The equable and uniform tenor of force in the *primum mobile*, or first mover, which is either a *weight* or a *spring*.

2. The free and natural action of that part which governs and regulates the motion in clocks and watches, and causes them to divide time as equally as possible. This is done by a *pendulum* or *balance*.

3. The goodness and truth of the work of the wheels and pinions in the body or *train* of the clock.

Now the reason on which I ground my new plan or construction of a table-clock, is owing to the observations I have long made on the defects of the common sort of table-clocks in every one of the above-recited essential particulars. For, in the first place, every clock-maker must allow that the action of a *weight* is the *only* principle for generating equable motion that nature affords, at least much more so than a spring and fusee can be, though it has not been as yet applied to table clocks. In the second essential, the *pendulum*, I shall be more particular in its defects in common clocks by and by; and shall only say, with regard to the *train* of clocks, as they are usually made, it is very different from that in mine.

In the new construction of the table-clocks I here propose, it is necessary then that they should go by a *weight;* and that this weight should not exceed what is required to actuate the pendulum in a proper degree, and accordingly it is adjusted to answer that purpose adequately.

In the next place, the train of wheel work in these clocks is quite of a new form; for, as they shew the time in half-seconds, the hour, minute, and second hands are all upon separate axles, and independent of each other, there being nothing of that *intercalary* work between the dial-plate and body of the clock, as in all others; and by this means the system of wheels and pinions is undoubtedly rendered the most simple and perfect that this sort of mechanism will admit of.

Further, a new calculation for the train in general, and quite a new form for the swing-wheel became necessary, inasmuch as this wheel immediately acts upon the pendulum, and not only communicates to it the requisite impulse, but likewise determines the *arch of oscillation* or vibration, upon which the truth of clock-work so much depends.

In order to make this important article of the pendulum as plain as may be, I shall here explain its principal properties by a figure in the frontispiece. Let *a* be a heavy ball, suspended upon the string A *a* from the axle, or centre A, on which it is supposed to move with the utmost freedom. Then if this ball were brought to the point *a*, and there let go, it would descend and vibrate through an arch a *a*, bisected in the point C by the perpendicular line A Q.

But this arch or extent of vibration will very sensibly lessen, and in a few minutes be reduced to the small arch G H, of about half an inch in length, in which the pendulum will continue to oscillate for a considerable time, 'till this also gradually decreasing, the ball or pendulum will at length be reduced to rest in the lowest point C.

Now the pendulum is reduced to rest by the action or resistance of the medium, axle, &c. From hence it appears that a force must be derived from the *primum mobile*, or weight, through the train of the clock, and impressed on the pendulum, that shall be a little superior to the retarding forces of resistance, that so the clock may be constantly kept in motion.

Since all the truth of a clock depends upon an exact equality in the times of vibrations of the pendulum, and these times can never be equal but when the pendulum moves in the arch of that particular curve *b c*, which is called a *cycloid*, and that must be effected by making the string of the pendulum apply itself to the two inverted parts of the same curve A *f*, A *g* (called *cycloidal cheeks*), therefore it will follow that no pendulum, left to itself, can oscillate in equal times; as, in that case, it must describe the arch of a circle *d e*.

But since the cycloid *b c* and the circle *d e* do both pass through the point C, and that therefore they must nearly coincide for a small space on either side, as from C to G and H; consequently, if the pendulum vibrates through a very small arch G H, of about 3 or 4 degrees, or half an inch, it may be deemed as vibrating in the cycloid *b c*, and therefore in equal times. Hence the reason why the pendulums of these new clocks oscillate through so small an arch as half an inch, or three-quarters at most.

Whereas in the common clocks the pendulum, P, is often observed to swing through an arch of a circle, P *P*, of 4, 5, and 6 inches length, and therefore far enough different from the *cycloid* R *R* through the same point Q. Hence it must be easily seen, how far such pendulums must be from any disposition to vibrate in equal times, and that they never can go true but by violence and unnatural methods; for, as I observed, no pendulum does naturally vibrate in a large arch; the continued large oscillations of pendulums, therefore, in common clocks must proceed from the too great force or violent action of the spring.

It is also well known, that for a pendulum to vibrate in a given time it must be of a given length. By the length of the pendulum is meant the distance between the centres of motion and of oscillation; but where either of these centres can be found in the common pendulums of clocks, there are no means to discover. In the clocks I make, these centres are truly determined, and consequently the length of the pendulum, by *mathematical calculation*.

As the equability and truth of the oscillation of pendulums depend on their length, it is evident, unless that length be constant, the equal motion cannot be so. But *metalline* substances of every kind have their lengths variable by *heat* and *cold;* consequently the rods of the pendulums for these new clocks are not to be of metal, but of such a substance as will not sensibly alter in length by the most extreme degrees of heat and cold that any clock can possibly be exposed to.

Lastly, the length of a pendulum, constructed as it ought to be, has also a relation to the ratio there is between the weight of the rod A B, the weight of the bob B S F T, and the diameter thereof, B F: these are therefore most scrupulously to be attended to, and determined by a balance.

But, that the whole of this new plan of clock work may appear in one point of view, I have here connected all the essentials as follow:—

1. The distance A C of the centre of the ball or bob C from the centre of motion A.
2. The distance, A D or A E, of the centre of oscillation, D or E, from the centre of motion A.
3. The radius B C of the bob, which in these clocks is a circular plane, B S F T.
4. The weight of the bob.
5. The weight of the rod.
6. The arch or chord of vibration, G H or N O.
7. The peculiar nature and substance of the rod.

These are all determined with the greatest precision in these new clocks; but in the construction of clocks in the common way, there is not the least regard to the due quantity of any one of them. In short, all that nature, by *number*, *weight*, and *measure*, can impart to mechanism, is here applied to the utmost of my power.

These clocks go eight days; and being constructed upon so natural and perfect a plan, they merit to be regarded as *regulators*, by which watches and other less accurate timepieces may be set, and by which the nicest purposes of astronomical and chronometrical observations may be answered, as they may be stopped at so minute and critical a point of time as half a second, which is twice the exactness of the usual large regulators.

If the motion of the clock should at any time be stopped, by forgetting to wind it up, or otherwise, it may be set by a dial adjusted by a magnetical needle, which is also contrived to answer that purpose in the best manner, in any latitude less than 60 degrees; and to that end I have placed in the clock a Table of the Equation of Time, rectified to the present year 1770, and will serve for many years to come without sensible error.

For astronomical uses it should be set by the altitude, or equal altitudes of the sun; and, by observations of the stars, it may be always made to shew the mean time correctly, as they very well know how to effect who are concerned in these curious parts of science, without any directions from me.

If any person be desirous of seeing a genuine demonstration of the truth of every thing here advanced, he may be fully satisfied by consulting a treatise intituled "*Institutiones Horologicæ, or Physico-Mathematical Theory of Clock-work*," which was published some years ago as a part of my *Mathematical Institutes*, in 3 vols. 8vo.

And it may be some satisfaction to the public to be assured, that I have placed the rods of these pendulums upon a *pyrometer*, which magnifies the extension of any substance 3000 times; and though placed very nigh to a great fire there appeared no motion of the index, which for metals would have made several revolutions with that continued degree of heat.

At the same time I kept them in a glass tube in a *freezing mixture* (of salt and snow), but could perceive no sensible difference in the length. The same rods, taken hot from the fire, were immediately plunged into spirits of wine, and after being thoroughly saturated with the liquor, discovered no difference in length that could affect the nicest time-piece whatever.

Therefore, by small degrees of heat and cold, moisture and dryness, the rods of these pendulums cannot be affected in any sensible degree, nor be productive of the errors which are common to those of metal. And therefore what Hugenius observes of his clock, whose pendulum oscillated in the arch of a cycloid, may with almost equal truth and propriety be applied to these, viz., "That such a clock must either measure time truly, or not at all." And I hope it will not be presumptuous to affirm, "That these are the *first* and *only* clocks that have been constructed with an *invariable pendulum*, of a *half-second* length, and put in motion by a *weight*."

There is indeed an account of a *pendulum immutable* in vol. vii. of the "*New Commentaries of the Imperial Academy of Sciences at Petersburgh*." But when we are told, that it had a steel rod; and that it would not perform accurately but in one constant temperature of air, regulated by a thermometer, we have no reason to think it could deserve that title in the least degree, but just the contrary; for no *metalline* pendulum was ever yet heard of, that was not of a mutable nature. Besides, this pretended immutable pendulum was not applied to a clock, but to a particular chronometer. And therefore, as it is now near twenty years since I first shewed and recommended this truly *invariable pendulum* in my public lectures, as the only genuine regulator of motion in clocks, I have no doubt at all but that the ingenuous part of the public will allow my right to the invention.

Every purchaser of these new clocks may be assured that the true and perfect adjustment of the pendulum, in regard to its due *length* and *weight*, is performed by my own hands; and that the greatest care will be taken that the work, in every other part, shall be good. And, what is moreover quite peculiar to this construction, is, that the length of the pendulum being invariable, is to be always truly assigned and determined (when required) by a *gauge*.

In the works of Nature we never fail to admire the most evident simplicity and congruity of parts; and in works of art, "The more simple the mechanism, the more perfect the machine," has been an indisputable maxim, and scarce ever contradicted but in clockwork; where, to produce the most perfect time-piece, we have seen the most complex and intricate mechanism employed. But, as the public has paid pretty well for such absurd procedures, I hope the new construction of a clock here offered them, as it consists of the least number of parts to answer such extensive and accurate purposes, will be favourably received; and no greater success is desired than what is proportionable to the merit of the machine.

Fig. II. is a view of the face of the clock; and Fig III. of an horizontal *dial* for setting the clock by means of the Equation Table. This dial has one requisite for this purpose, which is always wanting in common horizontal dials though ever so large; it is besides applicable to all other purposes of a portable dial, and will serve for all latitudes from 20 to 60 degrees.

DOUBLE VOLUTE BALANCE SPRINGS.

To the Editor of the Horological Journal.

Sir,—The inference to be drawn from Mr. Hammersley's remarks, in No. 21 of the *Journal*, is, that the spring which he calls "a double flat spring" originated with himself more than two years since. This I have no desire to make a question of,—it may be so. But as my Double Volute Springs have passed through the hands of various watchmakers for 30 years, and have been spoken of as an original principle, possessing all the properties attributable to the "double flat spring," the circumstances do not favour Mr. Hammersley's claim. I should not have troubled you with this, had Mr. H. not made the remark, that the mode described by me of making double volute springs is "uncertain and liable to error," and his adopting my suggestion of making them by machine principles. I candidly stated how I had made the original spring, without explaining later improvements.

If you have space for this and the two enclosed letters, the insertion will oblige

Your's respectfully,

May 21st, 1860. James F. Cole.

(Letter I.)

"*To Mr. Cole.*

"6, Park Place, Highbury, May 6th, 1860.

"Dear Sir,—My attention was called to an article in the 21st number of the "Horological Journal," which very much surprised me; it was in reference to your double flat spring. In justice to you as the inventor of that spring, and to corroborate your statements, I wish to inform you that a chronometer, named *James Cole, No.* 315, has been repaired by me in January, 1857; it has precisely the same description of spring as that new invention described in the Journal. I think, from the appearance of the watch, that it must have been made some 20 years since.

"I am, dear Sir, your's respectfully,

"John McLennan."

(Letter II.)

"*To the Editor of the Horological Journal.*

"84, Strand, May 10th, 1860.

"Sir,—Mr. Cole has requested me to certify that I saw a gold chronometer made about thirty years ago by him with a double balance spring. I have great pleasure in stating that it was well carried out, and though the chronometer had perhaps been cleaned many times by different watchmakers, the double spring shewed a remarkable truth. I pronounce no opinion upon its advantages.

"I am, Sir, your's truly,

"Charles Frodsham."

ABRIDGMENTS OF SPECIFICATIONS OF PATENTS RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

(*Continued from page* 128.)

1828, April 19.—No. 5639.

ULRICH, John Gottlieb.—This patent is for improvements to be considered as variations of the principles set forth in the specification of his former patent (No. 5136) for an improved remontoir detached escapement, and additions to the same

[Printed, 1s. 6*d.* See London Journal (*Newton's*), vol. 3 (*second series*), p. 88; and Rolls Chapel Reports, 7th Report, p. 127.]

1829, September 23.—No. 5850.

WESTWOOD, Robert.—The wheels and pinions are so arranged as to act under the barrel, that is to say, between it and the dial plate, thereby admitting within the limits of a pocket watch of the usual size a maintaining power of sufficient strength, with one winding up, to keep up a vigorous motion in the balance for eight days, or more.

[Printed, 5*d.* See Repertory of Arts, vol. 10 (*third series*), p. 143; and London Journal (*Newton's*), vol. 6 (*second series*), p. 268.]

1829, September 23.—No. 5851.

BROWN, Isaac.—1. Mechanism by which a watch is wound up. The winder is a circular rim, with an internal ratchet corresponding to the teeth of the barrel ratchet. The winder is let into the bezel, which slides round in a groove in the case. To wind up the watch the winder must be turned from right to left. If the watch be a fusee watch, the mechanism is slightly varied, and the winder will have to be turned from left to right. The winder may also be a winding rack to move on a pivot, and made to move backward and forward, but so as not to move the ratches in the backward motion.

2. Mechanism connected with the going fuzee and its spring detent. The perpetual ratchet is in a circular sink or recess at the under side of the great wheel, and within this sink is a groove in which the going spring is, one end being fastened to the great wheel, and the other to the ratchet. The hook of the spring will allow the ratchet to go in one direction, but not in the other.

3. A method of opening the bottom of the case by means of a spring knuckle, whereby the outside joint of the case is dispensed with.

4. Arrangement and combination of works applicable to the locking and unlocking of an alarum and to the setting off the striking part of a clock.

[Printed, 8*d.* See Repertory of Arts, vol. 9 (*third series*), p. 193; London Journal (*Newton's*), vol. 4 (*second series*), p. 264; and Rolls Chapel Reports, 7th Report, p. 130]

1831, January 22.—No. 6064.

ULRICH, John Gottlieb.—"Certain improvements in chronometers."

[No specification enrolled.]

1833, November 14.—No. 6506.

PACE, John.—A portable timepiece which shews the time by day, and whose dial can be illuminated so as to show the time by night. The dial is placed above the works; the motion work of the hands, and the movement of the timepiece being connected by an endless cord and pulleys.

[Printed, 5*d.* See London Journal (*Newton's*), vol. 17 (*conjoined series*), p. 217]

1833, March 20.—No. 6581.

BAKER, Thomas.—Consists in the application of the excentric movement, and that produced by the centrifugal force.

[Printed, 5*d.* See London Journal (*Newton's*), vol. 5 (*conjoined series*), p. 98; and Rolls Chapel Reports, 7th Report, p. 150.]

1834, October 17.—No. 6697.

LITTLEWORT, George.—1. "An improvement "on what is called the palette." The safety edges are at right angles to the stems or legs that carry them, and can therefore be cut and polished to form a truer portion of a circle.

2. "An improvement in hanging the spindle or "axle of the balance wheel." The end of the spindle formerly supported by the main potance, is hung to a support which is independent of the main potance.

[Printed, 5*d.* See London Journal (*Newton's*), vol. 20 (*conjoined series*), p. 451.]

1836, April 23.—No. 7067.

DENT, Edward John.—The inventor claims "the "use and application of any fit and proper flexible "defensive coating or varnish to the more effectual "prevention of oxidation or rust in the balance "springs and adjustments of chronometers and other "time-keepers." He describes a varnish suitable for the purpose, but expressly claims the application of *any* suitable sort of varnish.

[Printed, 3*d.* See Repertory of Arts, vol. 7 (*new series*), p. 271; and London Journal (*Newton's*), vol. 10 (*conjoined series*), p. 19.]

1836, May, 7.—No. 7083.

BANISTER, JOSEPH.—1. A mode of controlling the movement of the crutches in a clock through an invariable arc or length. The crutches being attached to the pallets which work in the teeth of the escape wheel, each pallet works on a separate arbor. Suppose the pendulum to be going towards the right, the left-hand crutch rests against one of two screws which are for the purpose of preventing the crutches, when released, from actually resting on the pendulum; the right-hand pallet is kept out of the perpendicular by a locking pin placed on a detent, which detent (being acted on by a weight and a spring), presses upwards against a pin. On the pendulum are two arms, with a balance at the end of each. As soon as (the pendulum going to the right) the balance touches the said detent, it forces it and its locking pin down, and the right-hand crutch is released. A counterpoise weight causes it to fall, striking the pendulum in its course, until it rests on one of the screws aforesaid. The pendulum, being thus propelled to the left, strikes the left-hand crutch, which gives way, and (in consequence of its pallet being raised from the escape-wheel, and the tooth of the escape-wheel, acting on the sloped part of the pallet) precedes the pendulum, passes its locking-pin, but is then by it prevented from returning until the pendulum releases it in the manner before described as to the right-hand crutch.

2. In a chronometer are two adjusting screws to prevent the pallet overshooting itself, which performs the like office of causing the propeller to move in a certain arc or distance.

[Printed, 11*d*. See Repertory of Arts, vol. 7 (*new series*), p. 195.]

1837, April 22.—No. 7350.

ULRICH, JOHN GOTTLIEB.—1. A mode of ensuring a continued action of the balance of a chronometer, by means of improved escapements or mechanism, which prevents the liability of the works being brought to rest by any sudden shock or circular motion of the instrument in the plane of the balance, which are effected by means of novel constructions of detents.

2. Self-acting regulators, or modes of compensating for the expansion and contraction of the balance spring under variations of temperature, which also afford the means of employing a material for the balance which will not be subject to magnetic influence; and also a mode of adjusting the compensating parts of the pendulum of an astronomical time-keeper.

3. An improved mechanism for stopping the hands of a watch without interrupting the action.

4. A new mode of locking and unlocking the striking parts of such chronometers as report the time.

5. A mechanism for discharging the striking parts of an alarm or warning watch.

6. A mode of preventing the oxidation of the springs of chronometers, by covering them with a thin coat of some metal which is not liable to become oxidated.

[Printed, 1*s*. 3*d*. See London Journal (*Newton's*), vol. 17 (*conjoined series*), p. 121; and Rolls Chapel Reports, 7th Report, p. 186.]

EQUATION OF TIME TABLE

For JUNE, 1860.

Day of the Week	Day of Mnth	At Apparent Noon — Equation of Time to be *subtracted* from Apparent Time.	Difference for One Hour.	At Mean Noon — Equation of Time to be added to Mean Time.
		m s	s.	m. s.
Fri. ..	1	2 26·36	0·384	2 26·34
Sat. ..	2	2 17·15	0·399	2 17·13
Sun. ..	3	2 7·56	0·414	2 7·55
Mon. ..	4	1 57·62	0·428	1 57·61
Tues. .	5	1 47·33	0·442	1 47·32
Wed ..	6	1 36·72	0·455	1 36·70
Thurs.	7	1 25·78	0·468	1 25·77
Fri. ..	8	1 14·55	0·479	1 14·54
Sat. .	9	1 3·04	0·490	1 3·03
Sun. ..	10	0 51·28	0·500	0 51·27
Mon. ..	11	0 39·26	0·510	0 39·26
Tues ..	12	0 27·03	0·518	0 27·02
Wed ..	13	0 14·58	0·525	0 14·58
Thurs.	14	0 1·97	0·532	0 1·97
		to be *added* to		to be *subtracted*
Fri. ...	15	0 10·78	0·537	0 10·78
Sat. ..	16	0 23·66	0·541	0 23·66
Sun. ..	17	0 36·65	0·543	0 36·64
Mon. ..	18	0 49·69	0·545	0 49·68
Tues ..	19	1 2·78	0 545	1 2·77
Wed ..	20	1 15·87	0·545	1 15·86
Thurs.	21	1 28·95	0·544	1 28·94
Fri. ..	22	1 42·00	0·541	1 41·98
Sat. ..	23	1 54·96	0·537	1 54·94
Sun. ..	24	2 7·84	0·532	2 7·82
Mon. ..	25	2 20·59	0·525	2 20·57
Tues ..	26	2 33·18	0·518	2 33·16
Wed ..	27	2 45·61	0·510	2 45·59
Thurs.	28	2 57·85	0·501	2 57·83
Fri ...	29	3 9·88	0·491	3 9·85
Sat ...	30	3 21·67	0·481	3 21·65

TO CORRESPONDENTS, &c.

All Communications for this Journal should be addressed to the EDITOR, *at the Office,* 35, Northampton Square, Clerkenwell.

N.B. Advertisements to be inserted in the Journal must be received before the 25th of the month.

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THE BRITISH HOROLOGICAL INSTITUTE.

THE HALF-YEARLY GENERAL MEETING.

On Thursday the 21st ult. the Half-yearly Meeting, for the election of members of Council and Officers, and on other business, took place at the Society's House, Northampton-square.

Mr. STODDART, as one of the Vice-Presidents, having taken the chair at seven o'clock, briefly stated the nature of the business of the evening, and announced that the ballot was then opened and would remain so until nine o'clock.

Mr. R. R. HUX had given notice of the following motion, which had previously received the sanction of the Council:—"That Ten per cent of all moneys received from and after the 24th June, 1859, be set apart to form a fund to be named 'The Institute's College Fund;' the same, in the names of three members of the Council, to be deposited or invested from time to time, so as to bear interest; such fund to be for the special object of enabling the Council in a few years hence to purchase premises for the use of the Institute; and that no appropriation of 'The Institute's College Fund' be made without each member of the Council having at least nine days notice of such intended appropriation; the notice to be considered duly served upon each member of the Council if sent by post or otherwise delivered at his last known place of abode."

Mr. J. C. Webb, Mr. Shackell, Mr. J. Bishop, jun., and Mr. Whitehorn, were appointed Scrutineers.

The Honorary Secretary, Mr. MYLNE, then read the following

REPORT OF THE COUNCIL FOR THE HALF-YEAR ENDING 15TH JUNE, 1860.

"Gentlemen,—In placing before you the Report for the past half-year, with an audited Financial Statement, the Council feel persuaded that you will be satisfied that the Institute has made great advancement during that period.

"They record with deep pleasure their satisfaction at the great services rendered so disinterestedly by a large number of the members, which have had the most beneficial influence, and tended much to the rapid advance of the Institute.

"The number of the members increases, and at present amounts to 316 annual and half-yearly members; of whom 59 are also founders and donors, 21 are life-members, and 10 are junior members. Seven founders, 2 life-members, 44 annual and half-yearly members, and 17 donors have joined since the last meeting, in December, 1859.

"The *Horological Journal* continues to make substantial financial progress. The sale is rapidly increasing; and we have to express our cordial thanks to the Journal Committee for their energetic performance of the arduous duties they have so kindly undertaken, and also to the many gentlemen who have enriched the Journal with their contributions.

"Meetings have been held for the following objects:—A Lecture was delivered by Mr. Thomas Leonard, on "Clocks and their Machinery," illustrated by numerous diagrams and models, to a large audience. A paper was read by Mr. Schweizer, on "The Art Decoration of Watches in Switzerland and in England," which displayed great research and a thorough practical knowledge of this interesting and important question. A discussion afterwards took place on the same subject, at which the opinions of the most eminent artists in that department of our trade were given freely, and, we trust, advantageously.

"The Lecture on Mineralogy, with especial reference to the minerals used in watch-jewelling, delivered by Professor Tennant, F.G S., of King's College, was received with the greatest interest, and was replete with the most valuable trade information. We may indulge the hope of hearing that gentleman again in continuation of this interesting science, so important to our manufacture.

"The Council will shortly have to announce a course of Lectures which have been kindly and gratuitously promised for the coming session.

"The Annual Dinner of the Institute, held on the 29th of February at Freemasons' Tavern, was a great success, although the absence of our esteemed President, through sudden illness, might well have militated against it. The attendance was excellent, and a spirit of good feeling and attachment to the Institute displayed, which was most gratifying. The utility of our organization, as a means of advancing the science and practice of horology, was ably enforced and advocated by many of the speakers; and there can be no doubt that the proceedings will long exercise a healthy and stimulating influence on a large proportion of the trade.

"As nothing can be done in the progressive study of our art without at least a rudimental knowledge of Geometry and mechanical and ornamental Drawing, it was natural that the formation of Classes for instruction and practice in these attainments should be among the most desirable agencies for the Institute to establish. The Council were deeply impressed with their importance; and, during the past half-year, they have established two such classes. They are happy to state that the step has been rewarded with the most complete success, whether as regards the able and indefatigable exertions of the master, the diligence and regularity of the pupils, or the progress made by them while under tuition. The Drawing and Geometry classes have more than answered the most sanguine expectations of the Council; and they anticipate from them the most enduring and valuable results

"The Council desire to tender their best thanks to the retiring members of the Council."

The Financial Statement, from December 15th, 1859, to June 19th, 1860, showed as the total of re-

ceipts 230*l.* 2*s.* 0*d.*; and of expenditure 143*l.* 2*s.* 1*d.*; leaving a balance in the Treasurer's hands of 87*l.* 0*s.* 8*d.*

Mr. CRISP moved that the Report and Balance-sheet be received and adopted.

Mr. CLIFTON having seconded the motion, it was carried unanimously.

ELECTION OF PRESIDENT, VICE-PRESIDENT, TRUSTEE, AND HONORARY SECRETARY.

The CHAIRMAN reported that Mr. Valentine Knight had been unanimously elected President for the ensuing year—(cheers)—and had signified his willingness to accept the honour thus conferred upon him. Mr. E. D. Johnson, of No. 9, Wilmington-square, would be elected as Trustee, in the room of Mr. E. J. Thompson, who had retired. Mr. Johnson now stood in a position which he (the Chairman) trusted would satisfy all the members that for the future they should be on very good terms and comfort one with the other. (Cheers.) The interest of the Institute would be uppermost in all their minds. The Vice-Presidents elected were Mr. James F. Cole, of No. 29, Devonshire-street, Queen-square; Mr. C. F. Klaftenberger, of No. 157, Regent-street; and himself (Mr. James Stoddart, of No. 13, Red Lion-street.) (Cheers.) Mr. Mylne had been unanimously elected Honorary Secretary. No gentleman could fill the duties of that office more efficiently than that gentleman had done; he (the Chairman) said that upon thorough conviction, and sincerely. (Cheers.)

PLURALITY OF OFFICES.

The CHAIRMAN said that a new question had been opened on that occasion in connection with the election of officers. By the rules nine officers were to be appointed—viz., a President, three Trustees, three Vice-Presidents, a Treasurer, and an Honorary Secretary; and, in his (the Chairman's) opinion, no individual should hold more than one of those offices. Unless that plan was followed out, the Society would be deprived of the assistance of a number of gentlemen, much to the detriment of its interests. Mr. Johnson had also been nominated to the office of Treasurer, but he believed it would give him greater gratification to fill the office of Trustee than that of Treasurer. As president of that meeting, he (Mr. S.) could not consistently propose any one candidate for two offices. He had addressed a letter to their President upon the subject, considering that he could not apply for instruction and advice to a better person. He had pointed out to Mr. Knight the inconsistency referred to. Nobody would wish more strongly to carry out the rule in that respect than Mr. Johnson. It had been argued that there was a precedent for the double election in the case of Mr. Knight himself, who held the two offices of President and Trustee. He (Mr. S.) suggested that, if it could be ascertained what Mr. Johnson's feeling on the matter was, it would be well to return him as Trustee, because that was an office for life, and was decidedly a higher position than that of the Treasurer, who was elected annually. Mr. Knight's opinion was, that Mr. Johnson should be elected Treasurer, as that was his original position; and that Mr. Hux, who had done the Institute excellent service, should be elected Trustee. As, however, he (Mr. S.) had reason to think that Mr. Johnson would prefer the Trusteeship, he had declared him elected to that office. If he was wrong, he was sorry for it; but he was thoroughly convinced he was right. That would leave the office of Treasurer open, and it would be for the meeting to say who should fill it.

Mr. WATSON thought that it was a matter with which the meeting had nothing to do. Mr. Johnson would be elected to the two offices, and might accept which he pleased. It would be for the members to act as they thought proper in reference to the matter afterwards.

The CHAIRMAN thought that though the Council had drawn up a certain programme, yet he, as Chairman, was bound to be guided only by the rules, which, although they had been infringed in the case of Mr. Valentine Knight, ought not to be broken again.

Mr. MARRIOTT denied that there was any rule preventing a gentleman from holding two offices.

Mr. CLIFTON thought that if one gentleman held a plurality there would be one officer less at the Council than there ought to be.

The CHAIRMAN announced that Mr. Knight, seeing the difficulty which was created by a man holding two offices, had determined to resign his Trusteeship, and suggested that some one should be elected in his place.

Mr. BROOKS thought that the Chairman was perfectly right in his definition of the law upon the point. Mr. Johnson originally proposed that the Council should be composed of forty members. It was pointed out to that gentleman that as there were nine other officers, that would make forty-nine; and that twenty-five or half that number would be sufficient. A compromise was made by adopting the present number for the Council—viz., twenty-eight members, and nine other officers. He had suggested to Mr. Johnson that the President, if elected a Trustee, would hold two offices. Mr. Johnson replied that, as the President and Trustees seldom attended the meetings of the Council, that would be no objection, and consequently the opposition was withdrawn. The Chairman of the last annual meeting, Mr. Hislop, struck out one return on the double nomination, and the next highest candidate on the list was made a member of the Council, as he declared that no member could hold two offices.

Mr. MARRIOTT did not think they could appoint other gentlemen to any offices unless they had first been nominated according to the rules.

Mr CRISP, in reply to a question put to him, reported that he had seen Mr. Johnson that day, and that gentleman had declared he would not accept the Treasurership under any circumstances, and that it would be a matter for his further consideration whether he should take that of Trustee.

The CHAIRMAN thought that the election had developed an imperfection in the rules. No nomination should be received unless the member proposing vouched for the consent of the candidate that he would stand if elected. If several gentlemen elected were unwilling to act, what a position the Institute would be placed in!

Mr. MYLNE remarked that when Mr. Knight was elected President he was a Trustee, and, as

such, elected for life. It would have been very wrong to prevent a gentleman having that honour conferred upon him because he had been kind enough to become a Trustee; and yet, if he resigned his Trusteeship in order to become President, he might afterwards find himself deprived of his Trusteeship. It was unfair to prevent a Trustee from becoming President, and it was that feeling which led to the exception in Mr. Knight's favour. At the same time he thought the Treasurer should be one person, and a Vice-President another. He thought that the rule could not be rigidly adhered to.

The Chairman.—If you had said that the rule could not be too rigidly adhered to, I should have liked it better.

Mr. Trewinnard had nominated Mr. Johnson to the two offices, and he (Mr. T.) contended that there was nothing in the rules to prevent him so doing. There was the case in point of Mr. Knight, who was President and Trustee. The offices of Treasurer and Trustee were quite distinct; the one was to hold the property of the Institute in trust, the other was to deal with its cash.

Mr. Marriott said that, if he understood rightly, Mr. Knight had been asked whether he would resign the office of Trustee.

Mr. Mylne replied that Mr. Knight in his letter stated that Mr. Stoddart had written to him stating he did not think it advisable for one person to hold two offices, and Mr. Knight had consented to another gentleman being appointed Trustee instead of himself. He further advised that Mr. Hux should be elected Trustee, and Mr. Johnson Treasurer.

Mr. Trewinnard looked upon Mr. Knight's letter as an answer to an application to him to resign his trusteeship, and that out of courtesy he had said "Yes."

The Chairman said, the answer was in reply to a private note of his respecting the evil of concentrating the offices.

Mr. Klaftenberger contended that it was a common thing in societies for a gentleman to hold two offices. He could point out half-a-dozen instances of the kind. He himself was Trustee and Vice-President of one. Mr. Hux had been named as Trustee; but he might aspire to become President, which, according to the law now laid down, he never could be while he was Trustee. That one man less would be placed upon the Council was not a sufficient objection to the double election. He (Mr. K.) was sorry that Mr. Johnson had not written to say which of the offices he would accept, which would have stopped all further controversy.

Votes of Thanks.

Mr. Marriott proposed the thanks of the meeting to their esteemed and valued Honorary Secretary, Mr. Mylne, who had performed the duties of that office ever since his (Mr. M.'s) resignation, and much more efficiently than he was able to do. He had written to Mr. Mylne a letter, requesting his name to be excluded from the list of candidates for the office of Councilman; but as he found that it had been retained, if he should have the honour of being elected he would serve, and, to the best of his ability, promote the interests of the Institute. He was, however, connected with so many societies that he should have been glad of the privilege of being released from duty in connection with the Institute. It had been said that it was bad to have too many irons in the fire, and that only one thing could be done well at a time; but he thought that if they could keep the poker, shovel, and tongs all at work, it was much better. He trusted that the Institute would prosper more in the future than it had done in the past. He should like to see the general body of the trade enrol themselves as members. He regretted the insurmountable barrier of the 12*s.* subscription, which kept out a large number of operatives who certainly would otherwise derive benefit from the Institute. If that was done, their rooms would not be so thinly attended; which, indeed, they ought not to be, looking at the privileges conferred upon the members, in a table well supplied with periodicals and pamphlets, and useful works in connection with the art of Horology, as well as a multitude of other advantages. Those who felt the importance of the Institute might still continue their subscriptions notwithstanding such reduction. He did not wish to reflect upon anybody, but he must confess that he had sometimes gone away from the Council-room with a feeling that their meetings had been a thorough waste of time. There ought to be a greater spirit of unity and of self-abnegation. They had but one object which they ought to consider, and that was the interests of the Institute. If they all felt that, he firmly believed they would meet with general sympathy, and do all the good which such an Institute was capable of effecting.

Mr. Jackson cordially seconded the proposition. He trusted that what had been said by their late Secretary regarding the Institute would be realized. At the same time he thought that in the hands of the present Secretary there was some guarantee that activity would prevail in its management. Notwithstanding all that had been said upon the subject, it must be remembered that the Institute was but in its infancy. It had only been established two years, and success in this as in most other matters must be the result of time and experience.

The resolution was carried unanimously.

Mr. Mylne was extremely indebted to the members for their kind vote. He had consented to serve a little longer as their Honorary Secretary, and in so doing would do the very best he could for the interests of the Institute. If he had not had the strongest possible desire for its welfare he certainly should not have consented to continue in his office.

The Chairman proposed a vote of thanks to Mr. Hux, the Treasurer. No one would demur to the fact that in handling the money and keeping the accounts there was some trouble. He had laid out their funds so as to get an interest upon them of 12*s.* 11*d.* The motion did not require a seconder; he would therefore at once put it.

The resolution was carried *nem. con.*

Mr. Hux returned thanks. The moment he saw that the establishment of an Institute in connection with horology was possible, he went to the first public meeting, and gave it his best support. Whether in or out of office, it would always be his gratification to endeavour to promote its welfare. He thought that it had arrived at a certain point

whence, by a very little exertion on the part of its members, it could in a short time take a high position. When gentlemen once began to take an interest in a society it is astonishing what an amount of good they can do for it. If every member would resolve to introduce a new one, which might very easily be done, in three or four weeks they might without any great effort double their numbers.

Mr. BROOKS proposed a vote of thanks to gentlemen whose names were always received with the respect which they deserved,—the Vice-Presidents. Having served some time with them upon the Council, he could testify to their exertions for the benefit of the Institute, and especially to the services of the Chairman, who, for some considerable time past, had devoted himself day after day —sometimes throughout the entire week—in arranging the accounts in such a manner as had met with the unqualified approval of the Auditors. From having worked with Mr. Stoddart on the Journal Committee, he knew the labours that gentleman had bestowed on the affairs of the Institute. He had rendered its accounts so plain, that any member could understand them. With regard to Mr. Cole, they could judge of the value of his admirable articles in the "Journal." Although they had not at present the services of Mr. Hislop, he (Mr. B.) hoped that before long they would have, as his exertions for the Institute in past times were worthy of the highest commendation. (Hear.)

Mr. HOLDSTOCK seconded the resolution, which was carried unanimously.

The CHAIRMAN always felt most awkward when talking about himself. Without taking all the praise awarded to him by Mr. Brooks, he might say that he had endeavoured quietly and assiduously to do a little work during the day, to make amends for his absence at night. Books being rather his *forte*, he had felt it his duty to throw his mind into that department of the Society's operations. He had particularly attended to the composition of a Subscribers' Subscription Book and Ledger. There were 371 names in the ledger. Mr. Mylne reported the number of members to be 316, having thrown out about 60 whose subscriptions were not paid up; but he would be a bold man who should say that all those men would cease to be members notwithstanding. He (Mr. S.) reckoned the number at 350, and in so doing was not very far from the mark.

Mr. JACKSON proposed a vote of thanks to the President, who had performed the duties of his office to the entire satisfaction of the members. It had not been their pleasure to have seen him so often amongst them as they could have wished, but his absence was not in any way attributable to indifference to the welfare of the Institute.

Mr. WATSON seconded the resolution, which was carried unanimously.

The CHAIRMAN proposed a vote of thanks to the Auditors, who had taken great trouble in investigating their accounts, which could not in any institution be thoroughly understood until they had been handled every day in the week. Mr. J. C. Webb, Mr. Holdstock, and Mr. Grimshaw were well entitled to thanks for their labours in that respect.

Mr. HOLDSTOCK returned thanks for himself and colleagues, who would always be found to do their duty.

The CHAIRMAN proposed a vote of thanks to the Council, including all the Sub-Committees. Not only on Wednesday evenings, but on every day in the week, they had a great deal of work to perform.

Mr. TREWINNARD returned thanks on behalf of himself and colleagues. Such a mark of confidence would no doubt stimulate all new-comers to a zealous performance of their duty.

The CHAIRMAN proposed a vote of thanks to the Trustees — Mr. Knight, Mr. Adams, and Mr. Thompson—gentlemen who held a high position in the society, and were very much respected by its members. The resolution was put and carried.

Mr. JACKSON proposed a vote of thanks to Mr. Gordon, Chairman of the Journal Committee and Editor of the Journal, who had performed his duties most efficiently, bringing to it great experience, leisure, and general qualifications, such as no other member of the Institute probably possessed.

Mr. MYLNE had much pleasure in seconding the vote, which he could most conscientiously do from his knowledge of the great labour which Mr. Gordon bestowed upon the editing of the "Journal."

The resolution having been passed,—

Mr. GORDON thanked the meeting for the recognition of his services, but said the greatest praise was due to the members of the Committee for the support they had given him. His only object was the success of the Institute.

Mr. MARRIOTT proposed a vote of thanks to the CLERKENWELL NEWS, and to Mr. Farmer its Editor. A cheaper and better paper, and one having a greater circulation, was not to be met with in any locality.

Mr. MYLNE had great pleasure in cordially seconding the resolution. It had been his business frequently to meet Mr. Farmer, and he could bear witness to the extreme willingness of that gentleman to promote the interests of the Institute.

The resolution was passed unanimously.

Mr. FARMER said that whatever affected the prosperity of Clerkenwell deeply interested him personally and officially. Nothing could be more important to a locality than the success of its staple manufacture, and that, in his opinion, materially depended upon the scientific education given to its workmen by such an institution as that in connection with which they were asembled. He should be happy to promote its objects by every means in his power.

THE DOUBLE ELECTION.

Mr. JACKSON again referred to this matter, respecting which nothing had as yet been done by the meeting. The course recommended for adoption by the Chairman seemed to him (Mr. J.) to be the most reasonable. They were desirous, no doubt, in that election, of bringing back into their ranks a gentleman who had heretofore been most active in the Institute, and he thought that the higher office of Trustee should be accorded to him. He agreed entirely in the view of the Chairman, that the offices of Treasurer and Trustee should be held by different persons. The one received the

money, and the other took charge of it, and was, to a certain extent, a check upon the Treasurer. By adopting that course they would show that they were anxious to avail themselves of Mr. Johnson's services if he would accept the office of Trustee, which was the highest of the two to which he had been nominated, it being for life, whilst the Treasurership was subject to annual election. He (Mr. J.) thought that the proper course to pursue under the circumstances was to elect some gentleman to the office of Treasurer *pro tem.*, because he could not be elected to it regularly without the previous nomination required by the rules. At the next general meeting he might come before the members and obtain their suffrages. That was the course adopted in reference to the election of their present Honorary Secretary, upon the retirement of Mr. Marriott. The office of Treasurer was required to be continually in operation, whilst that of Trustee wasnot so.

Mr. Trewinnard objected to the plan suggested by Mr. Jackson. The laws required a nomination fourteen days before the election. The members might have nominated any one they pleased to the Treasurership, but they had not done so; the only person proposed was Mr. Johnson. Whatever, therefore, was the result of the election, they must abide by it. If Mr. Johnson did not act after being returned, that would be a matter for subsequent consideration.

Mr. Jackson repeated his coincidence with the views of the Chairman, that it was against the sense of the law to appoint one gentleman to two offices. If he was out of order, the Chairman was equally so.

Mr. Watson again referred to the case of Mr. Knight, who held two offices, against which there was no law. Mr. Johnson must first be communicated with officially, and then whatever steps were requisite should be taken.

Reduction of the Subscription.

Mr. Henry Ganney, as a humble workman, but deeply interested in the welfare of the Institute, wished to call the attention of the meeting to the policy of lowering the subscription. It was said that you might touch an Englishman everywhere but in his pocket. The members should take a leaf out of the book of the Editor of the Clerkenwell News. They had in that parish the cheapest and the best paper in the world; and there was no reason why they should not have the best and at the same time the cheapest Institute in the world. If the 370 members were increased to 3700, the benefits of the Institute would be vastly augmented. The men who had a great love for their trade seldom rose to a very high position as regarded wealth. He could undertake to introduce twenty members with an annual subscription of 6s., and others might do the same. The impression amongst the operatives was, that the Council did not wish them to be members of the Institute—they only wanted masters and foremen. For his own part he should be happy to continue his subscription of 12s., because he felt it his duty to promote the interests of the trade in which he had been brought up by every means in his power. He should like to move a resolution for lowering the subscription to that sum.

The Chairman replied that fourteen days notice previous to a general meeting was required before that could be done.

Mr. Jackson informed Mr. Ganney that the question opened by him had not been wholly disregarded by the Council. The present subscription was as low as that of the Clerkenwell Working Men's Institute, or even lower, if the cost of the Journal supplied to the members was deducted from it. The expenses were cut down to a minimum amount. Not a penny was paid for editing or any purpose but printing. He (Mr. J.) would undertake to bring the proposal before the Council, and no doubt they would adopt it if they could with safety to the institution.

Mr. Trewinnard said that some six months ago it was decided at a general meeting of the Council to reduce the amount of the subscriptions of the country members from 12s. to 8s., and he did not think that they had received one additional subscription in consequence of their liberality.

Mr. Ganney did not see the force of the observation respecting the country members, because this was an institution mainly offering local advantages. Although working men might be thoroughly satisfied of the usefulness of the institution, and of its being worth the 12*s.* a-year, yet it was not so easy to convince their wives, when they wanted a pair of boots for the children, or the money applied for some household purpose. The plan might be tried; because it had been shewn, in the instance of the *Clerkenwell News*, that the lowest price might be attached to the best article.

Mr. Brooks had advocated the smallest subscription consistent with honesty or the payment of their debts, but he had never been able to get over the argument derived from the indifference manifested to the advantages of the Institute by the sons and apprentices of members, who by the rules were allowed to enter upon a payment of 3s. per annum. If low prices would bring fresh subscribers, that liberal arrangement ought to have done so; and yet, unfortunately, it had proved a failure.

Mr. Middleton said that the increase in that department had only been nine, notwithstanding the great inducement from the formation of classes.

Mr. Brooks contended that it was impossible to reduce the price without an equivalent increase in numbers.

The Chairman said that a difficulty would arise in the expense of commission for collecting. There seemed to be a feeling that *£ s. d.* was never to show itself in the Institute; if so, it should have fair notice of its exclusion. He hoped that after that night they should hear no more of such a spirit. If gentlemen gave their ten guinea subscriptions, they did not like in return to be called conspirators.

Mr. Ganney thought that much good might be done by a canvass of the trade.

Mr. Clifton suggested, as a compromise, the payment of half-a-crown a quarter.

Election of Professor Tennant as an Honorary Member.

Mr. Holdstock proposed the election of the Professor of King's College as an Honorary Mem-

ON THE EXPANSION OF METALS.

By F. CRACE CALVERT, Esq., F.R.S., and G. C. LOWE, Esq.

(ABSTRACT.)

One of us having been engaged for some time in investigating several of the properties of pure metals, it was thought desirable to take advantage of having pure metals at our disposal, together with a series of definite alloys of those metals, to determine their rate of expansion. And we were encouraged in pursuing this course of investigation, by finding that several of the authors who had previously published tables of the expansion of metals differed widely in their results. These discrepancies, having reference to some of the metals most extensively used, might, we thought be due either to the method employed, or to the fact that metals of different degrees of purity had been experimented upon. Therefore, being sure of the purity of the metals we intended to employ, we had recourse to a method the accuracy of which we trust will appear satisfactory.

Owing to the difficulty of obtaining the metals in a pure state in large quantities, we found it necessary to employ square bars, having a length of 60 millimetres by 10 millimetres of diameter. We therefore devised a process to determine with accuracy the expansion of such short bars. This, we believe, we have effected, as our apparatus will easily indicate an expansion amounting to the 50,000th of an inch, or about the 2000th part of a millimetre.

Omitting the description of our apparatus and of the details of our operations, which would be too long for this abstract of our results, we give here a Table of the general results obtained with the following metals :—

	Divisions of the Scale read off in 25,000ths of an inch in a rising temperature from 10° to 90°.				Divisions of the same Scale read off in cooling from 90° to 10°.				Mean for 100° calculated from these means, and corrected for expansion of vessel &c. by deducting 20.
	1st	2d	3d	Mean.	1st	2d	3d	Mean.	
Cadmium	174	171	172	172·3	176	173	172	173·7	196·2
Lead	155	156	157	156	161	160	159	160·0	177·5
Tin	142	142	145	143	147	148	147	147·3	161·5
Aluminium	120	120	120	120	122·5	121	122	121·8	131·1
Forged Zinc	119	121	120	120	120	119	120	119·7	129 8
Silver	110	109	109·5	109·5	111·5	110	110	110·5	117·5
Copper (pure) cast	106	105·5	106	105·8	103	103·5	107	104·5	111·4
Copper (pure) hammered	99	99	99	99	101	99	100	100	104·4
Gold	81	80·5	...	80·7	81·5	81	...	81·3	81·3
Bismuth	78	77	77·5	77·5	81·5	80	80	80·5	78·8
Wrought Iron	69	72	73	71·3	73·5	72	72·5	72·7	70·0
Cast Iron	67	68·5	68·5	68·0	68	70·5	70·5	69 7	66·1
Steel (soft)	66·5	62·0	63	63 8	66·5	65	66·5	66	61·1
Antimony	63	62	...	62·5	63	62	...	62·5	58·1
Platinum	57·5	...	...	57·5	58	...	...	58·0	52·2

From these observations we deduce the following Table of co-efficients of linear expansion from 0° to 100° :—

Cadmium (pure)	0·00332
Lead (pure)	0·00301
Tin (pure)	0·00273
Aluminium (commercial)	0·00222
Zinc (forged, pure)	0·00220
Silver (pure)	0·00199
Gold (pure)	0·00138
Bismuth (pure)	0·00133
Wrought Iron	0·00119
Cast Iron	0·00112
Steel (soft)	0·00103
Antimony (pure)	0·00098
Platinum (commercial)	0·00068

On comparing these co-efficients with those found by previous experimenters, we find that they agree very closely in those cases where commercial metals have been employed. But when we come to those metals which we employed in a pure state—such as lead, tin, zinc, silver, copper, bismuth, antimony, cadmium, and gold—we find a marked difference, which we attribute to our experiments having been made with purer metals ; and we are confirmed in this view by several series of experiments made with impure or commercial metals.

We give in our paper several series of experiments which prove that, as for conductibility of heat by bodies, their molecular condition exercises the greatest influence on their expansion. For example, we have found that the same bar of steel gives, according to its degree of tempering, the following ratios of expansion :—

	Raising Temperature from 10° to 90°.				Cooling Temperature from 90° to 10°.				Mean calculated and corrected for a bar of 60mm for 100°.
	1st	2d	3d	Mean.	1st	2d	3d	Mean.	
Steel bar as purchased ...	111	112	111·5	111·5	113	113	115	113·7	64·6
Steel bar at maximum of softness	107	108	107·5	107·5	107	112	111	110	62·5
Steel bar at maximum of hardness..................	141	145	140	142	138	139	139	138·7	84·0

The influence of the molecular state of bodies is also clearly illustrated in the class of compounds or carbonates of lime :—

	Rates of Expansion from 0° to 100°.
Chalk	19·6
Lithographic Stone	45·0
Stalactite	67·0
Marble	71·0

Influence of Crystallization.—Crystallization influences the expansion of bodies as it does their power to conduct heat ; thus, the same zinc cast horizontally or vertically has not only a different crystallized structure, but also expands in a different ratio :—

	Raising Temperature 10° to 90°.					Cooling Temperature 90° to 10°.				Mean for 100°, less correction.
	1st	2d	3d	4th	Mean.	1st	2d	3d	Mean.	
Zinc cast vertically....	224	226	227	226	226	232	233	234	233	266·9
Zinc cast horizontally	187	186·5	187	...	186·8	190·5	193	192·5	192	216·7

—*Proceedings of the Royal Society*, 1860.

ELEMENTARY PAPERS

ON MECHANICS AND MATTER IN MOTION.

[The following papers are intended to afford from time to time information to horologists on matters of general scientific interest.]

ON THE PENDULUM.

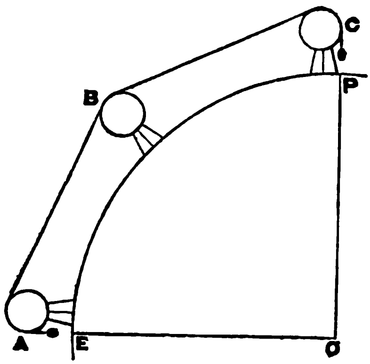
By a pendulum we are to understand a heavy body suspended from a fixed point by a rod or cord, and made to swing backwards and forwards by an impulse which draws it out of the perpendicular direction. This simple instrument is of the greatest importance to us in the measurement of time, and therefore in the determination of a vast number of natural phenomena. Thus, in astronomy the exact determination of time is necessary for almost every observation of the heavenly bodies ; and it was by accurately observing the difference in the number of beats of the same pendulum during a given time at different parts of the earth's surface, that the difference between the polar and equatorial diameters of our globe was first ascertained.

I must now state that the attraction of gravitation diminishes as the square of the distance increases, and consequently the downward pressure of a body (that is, its weight) would be less if it were removed to a height above the earth's surface sufficient to make the difference perceptible. This can scarcely be proved by ascent in a balloon or up a mountain, as a height of three or four miles is not sufficient, but it is clearly shown to be the case by experiments made on different parts of the earth's surface whose distance from the centre varies considerably. The earth is not perfectly spherical in form, but is flattened at the poles ; and the distance of its surface from the centre is only 3950 miles at the poles, whilst it is 3963 at the equator. This difference of 13 miles is quite sufficient to produce a marked effect upon the attraction of bodies towards the earth. It has been found by accurate experiments that the motion of a pendulum, which is entirely dependent on the force of gravity, is much slower over the equator, where the attraction is less, than it is in temperate regions or near the poles, where the attraction is greater in consequence of the shorter distance from the centre ; and from experiments of this kind it may be calculated that at the poles a body which would be drawn downwards (or towards the earth's centre) at the equator with a force of 590 lbs. will be drawn down with a force of 591 lbs. It is obvious, that if we balance a body in a pair of scales with weights equivalent to 590 lb. the scales will remain balanced in whatever part of the earth's surface we try the experiment, because the variation in the earth's attraction and in the downward pressure

it produces would be the same for that which each scale contains. But if the experiment could be tried with a spring dial weighing machine, we should find that the same weight which would cause the hand to point to 590 lb. at the equator would cause it to point to 591 lb. at the poles, since the downward pressure of the body is increased without any change being made in the resisting power of the spring.

The same fact may be illustrated in another way. Let us conceive a weight, E, *fig.* 1,

Fig. 1.

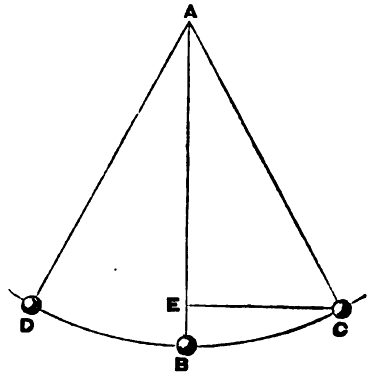


suspended at the equator by a string which should pass over a pulley A, and be conducted over the other pulleys, such as B, C, along the earth's surface, till the other end hung down at the pole, where a weight P is suspended by it. Now, if the weights E and P were such as would balance each other when placed in an ordinary pair of scales, they will not pull equally upon the string under these circumstances, for the weight P will be more powerfully drawn by the earth's attraction at the poles than the weight E will be at the equator; and, in fact, a mass of 590 cubic inches at P would balance a mass of 591 cubic inches at E. The difference is greatly increased by the action of centrifugal force, as will be explained hereafter.

There is little difficulty in comprehending certain obvious principles on which the action of the pendulum depends. We shall in the first instance, for the sake of simplicity, consider the weight or bob as spherical, and the line that suspends it as having itself no weight, so that the centre of gravity of the whole is in the centre of the bob.

Let A B, *fig.* 2, be such a pendulum hanging at rest from the point A. It is obvious that this will be in a state of rest only when it is in the lowest position that it can assume, which is of course when the line A B is perpendicular. But suppose that the ball B

Fig. 2.



is drawn or pushed out of the perpendicular, as to C; then it will tend to return to the point B, precisely as would a rounded body set free to roll down an inclined plane, since in so doing it will descend through the height E B. But its motion, at first slow, will gradually increase in rapidity, and by the time that it has arrived at B it has acquired a considerable velocity. This acquired velocity is sufficient to carry the body onward in the same circular line, even though it is no longer descending; but, having passed the lowest point B, it begins to rise again. For it will be evident, from the law of retarded motion, that the velocity gradually acquired by the ball in its accelerating descent from C to B is exactly that which if applied in the opposite direction to the ball when at B, would move it from B to C with a velocity gradually retarded by the influence of gravity, and which, acting on it in the direction B C, will carry it onwards to the point D at an equal distance on the other side. At D it would come to a stand, the moving power being then expended, Having arrived at D, it recommences its descent towards B, and gathers, as before, enough of force to carry it beyond B to C, the point from which it started, and from which it will again return in the same manner.

The vibrations of such a pendulum, even if friction could be done away with at the point of support, must come to an end in no very long time, since the extent of every one is rendered less than that of the last by the resistance of the air. A pendulum made to vibrate in a perfect vacuum, however, will continue for many hours.

(*To be Continued.*)

HARDENING AND TEMPERING OF STEEL.—The ashes of peat have been found especially valuable in hardening and tempering steel for the main springs of chronometers and watches.

A FEW WORDS

TO DO JUSTICE TO

ENGLISH CHRONOMETER, WATCH, AND CLOCK MAKING;

With Remarks on the ordinary Compensation Balance and on Captain Long's *Balance, as described in No.* 22 *of the Journal, fig.* 1.

He must be a bold man who in the present almost perfect state of chronometrical science attempts a new compensation balance, especially if he has not a great amount of practical experience and knowledge of the subject. I do not know what experience Mr. Long may have had, nevertheless I feel indebted to him for his communication. It would be very interesting to submit his chronometer to the usual tests; but he does not inform us what is its construction, nor the character of the two chronometers with which he compared the one with his own compensation balance. They might be defective instruments, and therefore be no evidence of the superiority of his own; beside which the Arnold compensation balance is perfect for all practical purposes for a range of 30 degrees of temperature —say, between a temperate climate and the torrid zone. There is not a spot on the globe where at sea the temperature exceeds 85° at fifteen feet above a ship's deck, and a ship's cabin seldom exceeds 80° to 87°, the mean temperature of the navigable ocean ranging from 50 to 80 degrees. Having always a large number of chronometers rating, I on one occasion had twelve that had been out between London and Jamaica and had performed in a manner I have sometimes known in a four and six months voyage out and home. These chronometers were not out two miles of longitude, which equals eight seconds of time. They were by the following makers:—two by Brockbank & Atkins, two by M'Cabe, three by Litherland & Davis, one by Heyes, and four by C. Frodsham. Their uniformity was wonderful. I examined their timing in temperature;—they were nearly all alike, as follows:—

	Sec.
At 88°	— 0·0
„ 68°	+ 0·4
„ 55°	— 0·0
„ 34°	— 2·7

It has been by such chronometers as these that the globe has been surveyed and charted, and that the unrivalled reputation and confidence which is placed in English marine chronometers has been acquired. I can only say, that unless a compensation balance of equal simplicity to the present one can be found, I would never recommend its application. We have many most ingenious appliances to the present compensation balance, to remedy its small error; but I would never trust myself to sea with any of them. The error in the Arnold compensation balance can hardly be called an error; it is a variation which follows a fixed and well-known law, and can therefore be tabulated. All astronomical instruments are known to have their errors, but they can be determined and then allowed for; why not, then, give with each chronometer rate an equation of first and second differences—the latter to be employed only in extremes of temperature.

The balance which Mr. Cole calls a "non-resisting balance" is one of John Arnold's early plans; but as it is not likely ever to be put in practice, I need make no remark upon it beyond this,—that resistance is essentially the base of compensation. Compensation is effected by one metal resisting another; this resistance is equal and contrary—if it resists in going in, it equally resists in going out. By the happy combination of two metals of different dilating powers — a plan that was suggested by Harrison, and put into practice by Arnold—the error of 400 seconds per diem was reduced to between three and four for a change of temperature of 60° of Fahrenheit. Surely science has in store a remedy for this small error, although it has hitherto baffled for fifty years the researches of the most skilful; but it must be sought by those who are well acquainted with what has been done, or they will only repeat what is well known and laid aside.*

I have recently made a most searching investigation into the nature and action of the compensation balance, and during the excitement of these experiments no less than 15 compensation balances were constructed—

* It is quite a mistake to connect the well-known law of acceleration of a hardened and tempered steel balance spring with the contraction or age of the balance. Harrison first pinned the two metals together, and so did Arnold; but the latter soon adopted the unrivalled method of soldering them together by fusing the brass upon the steel. If their argument is worth any thing, they ought to be able to inform us how much less the balance would accelerate in an old well-seasoned balance; and how much less will a plain balance, say of gold, keeping the chronometer in a mean temperature? Again, if the balance is the cause of the acceleration, how is it that a spring loses on its rate when made of soft steel or gold, and even double its worst acceleration when the spring is made of glass? This subject is so well understood by marine chronometer makers, that it appears to me remarkable that Mr. Cole should have written upon it before he had the proper elements o the subject.

all different, and each *à priori* promising perfection. But the impartial and rigid test of the oven and the ice chamber reported them not perfect.

The false motion of the compensation balance producing the subtle error was discovered to be about a millionth of the diameter! These interesting facts I intend shortly to publish for the benefit of chronometrical science, and my friend Mr. Cole and others who have never been engaged on marine chronometers will then have such data laid before them that I hope to get the same valuable hints as I have already received in bringing the best English watches to their present high and satisfactory state of perfection. Now so perfect and well established are the principles of high class English watchmaking, that all we require is a larger number of talented workmen to carry them out in greater quantities.

A perfect compensation balance is now the only thing left to be discovered. This is to the watchmaker what squaring the circle is to the mathematician — a problem, no doubt, equally subtle, equally difficult; and its discovery would be a golden feather in the cap of English chronometer makers, who have already lent such valuable assistance to astronomy and geodesy.

I intend also, as soon as possible, to publish my tables of watch and chronometer proportions, which will not only facilitate the operations of the workman, and excite in his mind a love for the knowledge of the beautiful laws he is carrying out, but will also interest and instruct the public, so as to enable them to become better judges of the art, and impart to them a knowledge which will ensure them a good watch at a fair price, while it will in some degree neutralize the large sums now spent in advertising and puffing off the greatest trash, and ensure to good workmen a larger share of the public favour, which their talents so well merit, and leave very inferior goods to be sold by puff and advertising. It is, no doubt, a great discouragement to good workmen; but if the best work is carried out in a business-like manner and sold to the public at a fair price, the market for the best watches will soon increase. The world is growing rich, and a good English watch will always meet with encouragement, and, depend upon it, quality will prevail in the long run; and if we go on making our best watches as well, as perfect, and at as moderate prices as our marine chronometers for only a few years, it will open up to this country a large demand for our best productions. The ships of every maritime country now sail with English chronometers; and every astronomical observatory in the world has an English astronomical clock as its standard of time.

Now that marine chronometers are almost perfect, in the construction of which the attention and study of our best men have been hitherto absorbed, greater attention is devoted to watches, and a wonderful advancement has been effected since 1851. Railroads also have given a great encouragement to the production of good English watches; you now meet men who challenge you to Greenwich time, and where there used to be a difference of minutes there is now frequently only a difference of a few seconds.

I was told the other day by a gentleman, that he met in Syria two travellers who challenged him to the Greenwich time, he having a good English watch with him and only just out from England. They differed 15 seconds. The two foreigners had three of the best English chronometer watches; and they assured the English traveller they were sorry to differ with him, but they had only been four months out since they had the time, and they were sure they were right. I had the honour to be the maker of one of these watches; it had gained 40 seconds in four months; it was decided by its rate to be fast 40 seconds, its error in time 10 seconds, in longitude 2½ miles. The others were by an eminent London chronometer maker—I did not hear his name. I hope Dr. Livingstone has got such chronometer watches with him; we shall then, in addition to the latitude, know the longitude. What a glorious thing it would have been for geographical science if such means had existed in antiquity. What knowledge then might have been transmitted to posterity! The sites of Nineveh and of Carthage would never have been lost. The source of the Nile, and the fruitful plains in Africa and Asia that once existed, would now be easily traced.

Such are the interesting facts associated with the science of timekeeping. Many of the great tracts of country in Russia and China are now surveyed by chronometers, where the time and expence of a trigonometrical survey would almost preclude its accomplishment.

With my best wishes and thanks to English workmen for able assistance, I am, Sir, your most obedient servant,

CHARLES FRODSHAM.

84, Strand, London.

Biographical Notices of Eminent Horologists.

JOHN ELLICOTT, F.R.S.

Though nearly a century has passed since John Ellicott departed this life, yet how familiar is the name to horologists; some of his time-keepers still remain, and are in every respect remarkable for the beautiful finish of the various parts. He was born about 1700; his father was a clock and watch maker. His grandfather, who was a native of Bodmin in Cornwall, settled in London at the time of the formation of the Bank of England, having been specially engaged to assist in its establishment. The family are believed to have sprung from the west of England, as in 1620 arms were assigned at the Herald's visitation to an "Ellicott of Exeter," bearing the same character as those earlier borne by the family name, and to the present time there are Ellicotts in various grades of life in the county of Devon. The race have also become somewhat extensively established in the northern portion of the United States, one member of which some years ago came to this country in the course of a lengthened foreign tour, and endeavoured to trace his connection with the subject of this notice, whose talent by tradition he seems to have been acquainted with.

Ellicott was a highly educated man, and corresponded with many distinguished philosophers abroad, particularly with the members of the Academy of Sciences at Stockholm, who always transmitted a copy of their works to him for presentation to the Royal Society. In religion he was a presbyterian, and on terms of special intimacy with Dr. Watts. In those days religion was not deemed to consist in unsocial gloominess and the condemnation of all recreation, and though few men were perhaps more rationally pious, yet Ellicott is represented to have been fond of cheerful society. Archery was his favourite pastime, and one solitary arrow yet remains of his full quiver. A rubber of whist was also keenly enjoyed by him; which, however, he never indulged in during his latter years on a Saturday evening, as on one occasion, when at afternoon service at the Elders' table, he indulged in a doze, from which he suddenly awoke and inquired "What was trumps!" He had a singularly handsome countenance, conveying the idea of mingled intelligence and firmness. Fortunately for his decendants (few indeed in number), there remains a fine portrait of him by Dance, afterwards *Sir Nathaniel* Holland, which Sir Joshua Reynolds pronounced to be the *chef-d'œuvre* of his rival: through the kindness of Mr. Vice-President Stoddart, a splendid engraving of this portrait is in our Institute.

Ellicott carried on business in the city of London as a clock and watch maker, his private house being at Hackney. He was married, in 1726, to a Miss Saunderson, of London, who is said to have been of the same family as the Peer of that name. An event occurred to Mrs. Ellicott so singular as to merit a brief recital here. It appears that when this lady was about fifty years of age, many of the family were informed of her sudden death; medical aid had been called in, and the announcement made that she had died in a fit; steps were taken as to the last offices, when by chance Dr. Fothergill, a Quaker and an eminent physician of that time, went on a friendly visit to Ellicott at Hackney, and, after close observation, he affirmed that life was not extinct, but that Mrs. Ellicott was in a trance. She continued in this state for eighteen days, when gradually she became conscious, and lived for many years afterwards.

Ellicott was elected a fellow of the Royal Society in October, 1738. Amongst the eminent men who recommended him for that honour, as being well versed in the principles of mechanics, astronomy, and experimental philosophy, were Sir Hans Sloane, Bart., Martin Ffolkes, John Senex the celebrated globe-maker, John Hadley the astronomer, and many others; the Royal Society rescinding in his favour their rule of not admitting a "mechanic." From the time of his election he became one of the most active members, serving on committees, regularly attending the evening meetings, and frequently introducing his friends to the society—among others, Dollond, Smeaton, and Ferguson. The way in which his intimacy with the latter originated was this:—Soon after Ferguson arrived in London he constructed a simple machine for delineating the Moon's path and that of the Earth on a long piece of paper laid on the floor; this was brought before the Royal Society by Martin Ffolkes, the president. Ellicott, who was present, stated that he had invented and constructed a similar machine many years before. Ferguson doubting the truth of this assertion, Ellicott invited him to dine at his house at Hackney, and there produced evidence which confirmed his statement. The intimacy thus commenced soon ripened into friendship, only terminated by death. A proof of the high opinion which the Royal Society had of Ellicott's attainments is furnished by the fact that upon several occasions works presented to them were referred to him to report upon their merits and contents. He served upon

the council for three years, and was the author of several papers read before the Society, the majority of which were afterwards published in the Philosophical Transactions. They are principally on subjects connected with experimental philosophy; the following are the most important :—"On an Instrument to measure the Expansion of Heated Metals;" another relates to the "Influence which two Pendulum Clocks were observed to have on each other." In this paper he refers to two regulators with which particular care was taken not only to have every part made with great exactness, but as near alike as possible. The ball of each pendulum weighed above 23 lbs; the cases (which shut very close) were placed sideways to each other, so near that the pendulums when at rest were little more than two feet asunder. Amongst other odd phenomena observed in them was, that in less than two hours after they were set going, one of them, called No. 1, always stopped. As it had always kept going with great freedom before the other regulator, No. 2, was placed near it, Ellicott conceived its stopping must be owing to some influence the motion of one of the pendulums had upon the other; and upon watching them narrowly, the motion of No. 2 was found to increase as No. 1 diminished. At the time that No. 1 stopped, No. 2 described an arc of 5°, being nearly 2° more than it would have done if the other had not been near it, and more than it moved in a short time after the other pendulum came to rest. On this he stopped the pendulum of No. 2, and set No. 1 going, the pendulum describing as large an arc as the case would admit, viz. about 5°; he presently found the pendulum of No. 2 begin to move, and the motion to increase gradually till in 17^m 40' it described an arc of 2° 10′, at which the wheel discharging itself off the pallets the regulator went, the arcs of the vibrations continuing to increase till as in the former experiment the pendulum moved 5°, the motion of the pendulum No. 1 gradually decreasing as the other increased, and in 45^m it stopped. He then left the pendulum of No. 1 at rest, and set No. 2 going, making it also describe an arc of 5°; it continued to vibrate less and less till it described but about 3°, in which arc it continued to move; the pendulum of No. 1 seemed but little affected by the motion of No. 2. Ellicott's explanation of the manner in which the motion was communicated to the pendulum at rest is, that as the pendulums were very heavy, either of them set going occasioned by its vibrations a very small motion, not only to the case that the regulator was fixed in, but in a greater or less degree to every thing it touched. This view he confirmed by placing the two regulators in a similar position on the stone pavement under the piazza of the Royal Exchange with somewhat similar results. Those of our readers who are interested in this subject must refer to the Philosophical Transactions, vol. 41, in which Ellicott enters fully into the matter. He also contributed papers "On the Specific Gravity of Diamonds," and "Experiments to discover the Laws of Electricity." Ellicott's theory was founded on the following data :—1. Electrical phenomena are produced by effluvia; 2. These effluvia repel each other; 3. They are attracted by all other matter. Although this theory attracted little notice at the time, yet if we substitute the word *fluid* for *effluvia*, these data are absolutely the same with those which were afterwards adopted by Epinus and Cavendish, and are the "basis of the only satisfactory theory of electricity hitherto made known." * Another communication was "On the Height of the Ascent of Rockets." In 1751 his paper entitled "Contrivances for preventing the Irregularity of Pendulums arising from Temperature," was published in the Philosophical Transactions, and caused considerable discussion at the time, as Ellicott in it claimed the principle of the compensating pendulum. A Mr. Short asserted that the invention was due to Graham; another party took up the cause for Ellicott, stating that he had applied it as early as 1738. Upon this Harrison addressed a letter to the Royal Society, in which he stated that the principle was his invention. A report on the whole subject was afterwards read before the Society by one of the fellows, who had investigated their various claims. The conclusions were, that Graham was undoubtedly the first inventor, but that Harrison had also constructed a clock on a similar principle without being aware of what Graham had done. Ellicott's (which in no way resembled either of them) was judged to be an improvement. The ball of Ellicott's pendulum is adjustible by levers, and very ingeniously constructed;— in fact, the production of a highly skilful artist.

He designed several of our public clocks, amongst them that of the London Hospital, and was appointed clockmaker to the King. The profits of his occupation must have been considerable, as from old memoranda a full establishment seems to have been kept, much hospitality shown, and yet property to a large amount was left, sufficient to enable his

* Thomson's History of the Royal Society, 4to, London, 1812.

family to continue in his own position in life. In addition to his English connection, he had considerable dealings in Spain, probably arising from his intimacy with a Spanish envoy, fond of scientific pursuits.

Ellicott died suddenly in 1772, having dropped from his chair and instantly expired. Of his children three died unmarried. A daughter was married to Mr. Crisp, governor of Bencoolen (Sumatra), in the East Indies. His son Edward married, about the year 1756, a Miss Lessingham, only daughter of a banker of that name. This Mr. Edward Ellicott pursued his father's occupation with full success, but scarcely with entire satisfaction, as his favourite study for several years was the theory of fortification. So highly esteemed was his knowledge in this department, that the commandant of Engineers at the siege of Bergen-op-Zoom asked him as a personal friend to accompany him to the Low Countries (probably at the close of 1758), where his singular energy and resources were not only conspicuous but of great advantage. Of the marriage of Mr. and Mrs. Edward Ellicott there were two sons and a daughter. The latter married a Dr. Sutton, and died a few years after. The second son succeeded to his father's business; but after a few years, on taking a partner, he gave up its duties, and became in 1795 a lieutenant in the Northampton Militia, and on the close of the war retired into private life for the chief portion of his remaining years; he died in 1836. The eldest son became vicar of Exton, Rutland; he left an only child, now rector of Whitwell in the same county, whose also only child is at present Professor of Divinity at King's College, London.

DOUBLE FLAT BALANCE SPRING.

To the Editor of the Horological Journal.

Sir,—When I first announced making my Double Flat Spring I had not the slightest idea of anything of the sort having ever been made before.

As a proof that I did not "adopt" Mr. Cole's "suggestion" of making these springs by "machine principles," I will merely add, that my springs made by machinery were placed in the Horological Museum long before his letter appeared in your Journal.

Mr. Cole is entitled to every credit for his springs, but they were quite unknown to me, and had nothing to do with my own invention. Yours respectfully,

J. Hammersley.

EQUATION OF TIME TABLE

For July, 1860.

Day of the Week	Day of Mnth	At Apparent Noon — Equation of Time to be *subtracted* from Apparent Time.	Difference for One Hour.	At Mean Noon — Equation of Time to be *added* to Mean Time.
		m. s.	s.	m. s.
Sun...	1	3 33·22	0·470	3 33·19
Mon...	2	3 44·49	0·458	3 44·46
Tues..	3	3 55·47	0·445	3 55·44
Wed..	4	4 6·15	0·432	4 6·12
Thurs.	5	4 16·51	0·418	4 16·48
Fri. ..	6	4 26·54	0·403	4 26·51
Sat. ..	7	4 36·22	0·388	4 36·19
Sun...	8	4 45·54	0·372	4 45·51
Mon...	9	4 54·47	0·356	4 54·44
Tues..	10	5 3·01	0·339	5 2·98
Wed..	11	5 11·14	0·321	5 11·11
Thurs.	12	5 18·84	0·302	5 18·81
Fri....	13	5 26·10	0·283	5 26·07
Sat. ..	14	5 32·89	0·263	5 32·87
Sun...	15	5 39·21	0·243	5 39·19
Mon...	16	5 45·05	0·222	5 45·03
Tues..	17	5 50·36	0·200	5 50·34
Wed ..	18	5 55·15	0·178	5 55·14
Thurs.	19	5 59·40	0·155	5 59·39
Fri. ..	20	6 3·11	0·131	6 3·10
Sat. ..	21	6 6·24	0·107	6 6·23
Sun...	22	6 8·80	0·083	6 8·79
Mon...	23	6 10·77	0·058	6 10·76
Tues..	24	6 12·15	0·032	6 12·15
Wed..	25	6 12·91	0·006	6 12·91
Thurs.	26	6 13·06	0·019	6 13·06
Fri ...	27	6 12·60	0·045	6 12·61
Sat ...	28	6 11·52	0·070	6 11·53
Sun...	29	6 9·83	0·096	6 9·84
Mon...	30	6 7·53	0·121	6 7·54
Tues..	31	6 4·60	0· 47	6 4·62

TO CORRESPONDENTS, &c.

All Communications for this Journal should be addressed to the Editor, *at the Office*, 35, Northampton Square, Clerkenwell.

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THE BRITISH HOROLOGICAL INSTITUTE.

CLASSES FOR GEOMETRY, AND MECHANICAL AND ORNAMENTAL DRAWING, AS APPLIED TO HOROLOGY, CONDUCTED BY MR. W. J. HOARE.

These Classes will recommence, at the Institute, for the new quarter, on Tuesday the 21st instant. Lessons are given in Geometry once a week, on Thursdays, and in Drawing twice a week, Tuesdays and Fridays, commencing each evening at 7.30. Fee, 5*s.* per quarter for Geometrical Class; 7*s.* per quarter for Mechanical and Ornamental Drawing; and 10*s.* per quarter for Pupils joining both Classes, payable in advance, including all Drawing instruments and materials except a board and T square.

*** Specimens of the Pupils' Drawings may be seen at the Institute.

ELEMENTARY PAPERS ON MECHANICS AND MATTER IN MOTION.

(*Continued from page* 149.)

ON THE PENDULUM—*continued.*

The length of time which is required for each vibration is but little influenced by the degree of swing which it has; that is, the vibrations occupy nearly the same time whether they are long or short. Indeed, for all practical purposes, the times of vibrations of different lengths may be regarded as equal, at least while they are not very long, as will be presently shown. This property is termed *isochronism,* from two Greek words signifying equal times; and the vibrations are said to be isochronous when long and short vibrations are performed in the same time.

The isochronism of the pendulum was not known before the time of Galileo,* and is said to have been first observed by him when very young, in the swinging of a lamp hung from the roof of the cathedral at Pisa. He was struck with the equality of the times in which the lamp continued to perform its vibrations as its motion subsided; "and this observation of a child became in the mind of the man a principle of philosophy, on which some of the greatest discoveries of science have been founded."

Isochronism is the name given to a remarkable property of all systems which are in equilibrium, namely, that when slight disturbance—be the same more or less—is given, the oscillations which take place are all performed in the same time, or so nearly in the same time that any acceleration or retardation is totally imperceptible. Thus, when a pendulum is allowed to vibrate till it rests it will be found there is no perceptible difference between the vibrations of longer and shorter extent; of which any reader may satisfy himself by attaching a weight to a string and observing the vibrations. But a still better proof may be found in a musical string. The finest ear cannot detect any difference between the pitch of a note made by a smart blow on the key of a pianoforte and that made by a gentle one; yet a very small difference in the number of oscillations per second would be perceptible, and the amount of disturbance from the position of equilibrium is twenty or thirty times greater in the first case than in the second. When under such different circumstances the longer space is described in the same time as the shorter, it must be that the force acting in the first case is greater than the second; and it is sufficiently known from experience that the more a system at rest is disturbed, the greater is the effort which it makes to return.

* Galileo closely adhered to the arguments of Copernicus, a Polish ecclesiastic, who ventured to disturb the rest in which mankind had slumbered for two thousand years by proclaiming that it is not the starry sphere but the earth—fixed and stable as it seems—which really revolves. The arguments of Copernicus were not at once able to change the opinions which had prevailed for ages, strengthened as these were by the supposed authority of Scripture; and it was not until the succeeding century that his doctrine was generally received. It was powerfully supported by Galileo, who was able by means of the telescope to adduce many additional arguments in its defence. For espousing this cause, however, he fell under the displeasure of the Inquisition, who had pronounced the doctrine of the earth's motion to be heretical, and he was led by the dread of severe punishment to promise not again to demonstrate that the earth moves. He seems, however, to have been unable to restrain himself from propagating what he believed to be truth, and, having again been summoned before the Inquisition and been wearied by long confinement, he signed, in his seventieth year, an abjuration of the doctrine to the defence of which he had devoted the best part of his life. Yet it is recorded of him that on rising from his knees, after making this recantation, he whispered to a friend who was standing by him, "And yet it does move." During his confinement he was visited by our own immortal Milton; who, doubtless, then learned from him many of those sublime truths which he afterwards interwove, with such striking effect, in his "Paradise Lost."

But, in order that there may be isochronism, it is not sufficient that the effort to return should increase with the amount of disturbance, but the increase must take place according to one particular law. This law is as follows:—the force of restitution must be always proportional to the disturbance, so that whatever force begins to act when the disturbance is a, twice as much acts when the disturbance is twice a; and so on for all proportions. That this law does prevail when the disturbance is not great—either absolutely or so nearly that its error is extremely small—may be proved both by theory and experiment.

But the time of the vibrations of the pendulum depends upon its length; and for every measure of length there is a certain determinate time. Thus, the length of a pendulum which should occupy one second in each vibration (such as that of a common eight-day clock) would be found to be about $39\frac{1}{7}$ inches, if we could measure the distance from the point of suspension to the point in which its whole weight might be regarded as concentrated. Now the length of a pendulum vibrating half seconds, such as that of a small table clock, would be about $9\frac{3}{4}$ inches, or one fourth of the last, reckoned in the same way; whilst the length of a pendulum whose beat occupies two seconds, is about $156\frac{1}{2}$ inches, or four times the last. Thus we see, that when the time is doubled the length is quadrupled, and that when the time is only half the length is a quarter. The law expressing the proportion between the time of vibration and the length of the pendulum is, therefore, simply this,—that the time varies in proportion to the square of the length. Thus, a pendulum whose vibrations are required to be three seconds in length must be nine times the length of that vibrating single seconds, or about $352\frac{1}{4}$ inches, whilst a pendulum to vibrate only thirds of a second must be only 1-9th the length of a second's pendulum, or about $4\frac{1}{3}$ inches.

In order that the laws regulating the action of the pendulum may be properly understood, it will be necessary to consider the mode in which the force of gravity will act upon bodies in causing their descent along inclined surfaces, whether these surfaces are plane or curved. Every one knows that a body left to itself will roll or slide down a hill, provided that its friction be not too great to prevent its being set in motion. We are continually in the habit of trying the level of a table, by putting a marble, a ruler, a pencil case, or any round body upon it, and observing if it has a tendency to roll in either direction, or remains at rest in all positions. We are also familiar with the fact, that the rapidity of the movement depends on the degree of steepness or inclination of the surface, that is, upon the amount of its fall in a given length,—being greater as this is increased. And it is further a matter of common observation, that the body commences its movement slowly, and increases in its rate until it arrives at the bottom. The modification in the law of gravity which is applicable to this case, is very easily understood. Putting aside the effects of friction and resistance of the air, a body moving down an inclined plane will have acquired, by the time it reaches the bottom, a velocity exactly equal to that which it would have acquired by falling directly through a height equal to that of the plane. Thus, suppose an inclined surface to be 144 feet higher at one end than the other, a body in falling directly through that height will occupy three seconds, and at the end of that period it will be moving with a velocity of 96 feet per second. This velocity, then, will be precisely that which the same or any other body would acquire in rolling down an inclined plane having the same height, whatever be the length of the plane. Thus the plane might be so long—a mile for instance—that its inclination would be scarcely perceptible; or it might be so short—200 feet for example—as to be steeper than the steepest accessible hill; in both instances, the velocity acquired at the bottom will be the same, so that the body would move over the same space of level ground in the next second; but the length of time necessary for the acquirement of that velocity will be very much greater in the former case than in the latter, and the rate of movement will therefore be much slower.

A FEW MORE REMARKS ON

ENGLISH CHRONOMETER, WATCH, AND CLOCK MAKING;

With CHARLES FRODSHAM'S *General* TABLE OF TRAINS, *for apportioning the Diameter and Weight of the Balance to the Velocity.*

Sir,—I have always expressed a great anxiety for the general advancement of the art of horology; and this I think the Horological Journal is likely to carry out, could we only enlist in the cause those whose experience and ability enable them to contribute so much valuable information.

I would venture to recommend that the spirit of controversy be avoided; but no one can object to fair healthy discussion, provided

that personal triumph be avoided. Contributors to a scientific journal should write from a love of the science itself; and if two or more write upon the same subject, so much the better. Men following the same pursuit are naturally liable to fall into the same or similar trains of thought; and they may arrive at the same conclusions by different paths, and so render their communications the more valuable.

But, Sir, there is an almost insurmountable difficulty arising from the want of proper universal gauges and of an acknowledged nomenclature instead of the wholesale use of technicalities. A proper set of terms for the communication of ideas among men exercising the same pursuit, is of paramount necessity; and, with the view of removing this difficulty, I have had a number of such gauges made, which I beg to present to the Institute, and recommend their adoption as the best means of obviating these technicalities, and giving to every part of the watch an intelligible expression in plain English terms of measurement and weight—in inches, grains, degrees, &c., &c. It is hardly possible to conceive the wrong done to science by technicalities, and to what an injurious extent they limit the power of right reasoning; whereas the advantage and saving of time in being able to express a practical fact by weight and measure in inches and decimals, is incalculable. A large number of such gauges are now in use, to the no small advantage of their possessors.

What, I may ask, would have been the value of the works of the great horological masters, whose inventions all able men so delight to honour, had they talked of "sizes" instead of measures and weights of known value? Mr. Reid urged the general adoption of the Sliding Gauge 40 years ago, yet for many years it was only to be found in the hands of a few marine chronometer makers. In addition to the sliding gauge to the 1000th of an inch, I hope also that the Engineer's Slide Rule will become general; and, as knowledge is power, you will soon see it profitably illustrated by the above two valuable tools. When one reflects that four-tenths of our countrymen depend for their living upon mechanical occupations, there cannot be a more noble act than for those who possess the knowledge freely to give it up for their country's benefit, and the maintenance in England of that pre-eminence in her manufactures for which she has been so long and so justly famed, and particularly for her watches and chronometers.

Although theoretical communications are very valuable and interesting, I should prefer, in this utilitarian age, those of a practical character, especially when supported by such undoubted evidence as shall give confidence and tend to facilitate the operations of those who are engaged in this minute and difficult art, which requires, in general, the aid of a strong glass to examine the correctness of its details.

Though men of great genius may kick against rules, they are not intended to limit their powers; but I presume no one will dispute the value of truthful data.

I enclose you a general Table of Trains, which I trust will be both interesting and useful. It shows that with the same mainspring and the same balance spring nearly 70 different characters of balance may be used by changing the velocity per minute, as per Table, which has a range of from 240 vibrations to 400 per minute. All have the same momentum, and the same mean vibration between the hanging and lying positions; the arc of vibration in the horizontal and vertical positions agreeing more and more closely as the velocity per minute increases; for, as a general rule, you cannot vary the diameter and keep a constant weight. It must also be well understood, that when we speak of momentum, it always has reference to the work done by a given mainspring and balance spring, driving a balance of a certain diameter and weight a definite number of times in 60 seconds of mean time, through an arc of vibration which is a correct mean between those of the horizontal and vertical positions, during an equal number of hours in each position. Thus, if a given mainspring and balance spring carry a balance whose diameter is 0·65 inches and weight 9 grains through a certain arc of vibration 270 times in a minute of mean time, the same mainspring and balance spring will only carry a balance of 0·65 in diameter and 4·10 grains weight at 400 vibrations per minute; but if you prefer weight to diameter, then you can only use 0·44 inches diameter with a weight of 9 grains.

In the following TABLE the Diameter and Weight of the Balance are apportioned to the Velocity upon the supposition that the watch has the same *momentum*—that is, that it does the same amount of work, and may be driven by the same identical mainspring (in a barrel of 65 hundredths of an inch diameter and $13\frac{1}{4}$ hundredths deep) and with the same identical balance spring; the law being, that the weights here given may be changed for a variety of others, provided the weight be increased or diminished in the inverse ratio of the square of the diameter, the square of the number of vibrations per minute, or the square of the number of degrees in the arc of vibration.

CHARLES FRODSHAM'S GENERAL TABLE OF TRAINS,

From 240 to 400 Vibrations per Minute.

*** The measures are in and the weights in grains.*

†

Model.

* The weight in the column where both are variable approximates to a mean of the weights in the two former columns, and the suitable diameter is obtained by calculation. The arc of vibration is constant, viz one turn and a half.

† Earnshaw's well-known train for his marine chronometers, and which Foreign Observers call the Chronometer Vernier, and use it as a medium of comparison for all other chronometers.

The most useful trains are:—For lever escapements, a velocity of 270, 280, and 288 per minute; for marine chronometers, 240, the well-known half-second beat; for duplex, 300 per minute; for pocket chronometers, 300 to 320. The latter is the celebrated Arnold train for his pocket chronometers. The question may probably arise,—Is there any time-keeping property in any particular train? None, or very little, except in extreme cases. There is doubtless, in all cases of this kind, a limitary principle:—thus, for a stationary instrument I prefer the slow half-second train; but this would be quite impracticable in a watch that is to be carried in the pocket, as the balance spring could not properly control its motion; besides which, the arc of vibration in the vertical and horizontal positions would disagree to too large an extent. On the other hand, in very high velocities the properties of the fly-wheel are lost, by the diminished weight, or diameter, or both, and the balance has thus a constant tendency to be overmastered by the spring and be brought to rest. Hence the trains above alluded to are those of almost universal use, and are found to answer admirably.

Among other difficulties which beset the aspiring student and impede his progress in the horological art, there is not, perhaps, a greater than the continued vaunting of the value of patents and pretended improvements, without any corresponding authentic data of their results by trial; because he is thereby led to imagine that there is some royal road to knowledge, which others possess and he does not,—that the art of horology is yet in its infancy,—and that there exist neither laws nor well-established principles for the workman's guidance. Let this sort of pretence be at once abolished, and let the student be taught that the laws and principles of watch and clock-making are not only well-known, but that they had attained a very high degree of perfection at the close of the eighteenth and commencement of the nineteenth century; and that the works still to be found in the museums of the rich and the libraries of the curious cannot, even in the present day, be viewed without exciting our astonishment and admiration—to wit, the productions of Harrison, no less marvellously conceived than carried out in unsurpassable workmanship and truth, his chronometers for instance at the Royal Observatory, and his wonderful astronomical clock, the property of the Royal Astronomical Society; the Breguet double-pendulum clock, a work of great merit; that master-piece of the mechanical art, Mudge's lever escapement with double roller, executed by Le Roux, the property of the Clockmakers' Company; the celebrated watch made for Queen Charlotte, with Mudge's fine lever escapement; and many others.

I could go on enumerating a long catalogue of works of ability, the sight of which would do more to refine the judgment, and advance the intelligent workman, than all the talked-of improvements and patents for the last 30 years, which have had no existence in reality. What I desire to be well understood is, that there is no royal road to learning—no patent that will make up for the want of ability to execute the delicate work of which watchmaking entirely consists—no patent that can supply the place of a thorough knowledge of the principles of the art, and of the cunning and talent of the hand to execute those principles in all their minute details. Look at the whole history of the chronometrical trials at Greenwich! the principle of construction was the same in all; it was the talent to carry them out that won the day. Look, again, at that valuable work lately published, "The History of Horological Patents," and you will perceive at once their uselessness, for not one of the whole number, that I am aware of, continues in use. Take as an example the Compensation Balance, which let us suppose to have been carried out well by a good workman; yet, if he is ignorant of its proper proportions, the compensation will be very defective; nevertheless it is not that the principle is defective, but the knowledge of the workman. The course pointed out by common sense is, for workmen to examine what have been the proportions of the brass to the steel in the better performing chronometers at Greenwich and elsewhere; what, are those adopted by makers who have devoted all their time to the art and science of adjusting and timing them, instead of each person as it were recommencing the art as a mere matter of fancy or taste, and thus virtually losing sight of all that mighty mass of facts and experience which exist upon this truly interesting subject.

Another very important matter connected with the balance spring is the selection of good steel as well as the care necessary to be bestowed upon its hardening and tempering.* How well all these interesting details are understood by the practical chronometer maker may be gathered from their successful results. But where, it may be asked, is the inquiring student to find a syllable of all these facts and experience? They are locked up as the secrets of the art among the possessors

* See my Paper "On the Isochronism of the Balance Spring," read before the Institute of Civil Engineers, 1847.

of real talent, who have seldom the time to write, and in many instances are prevented by their modesty from the due appreciation of their own abilities. Such men are not inventors !!! but their talents are not the less highly estimated, and in proportion to their own talents they may justly look with mistrust upon patent improvements, and especially so when they find (as is too often the case) that the most important points have been more or less neglected, and very little understood.

With regard to the proportions of the balance to the force of the mainspring, I was almost without a compass, and relied solely upon the collection of data from all the best watches of every maker, by which, coupled with a large number of tedious and accurately noted experiments and the valuable assistance of an amateur lover of the art, I was enabled to reduce the entire art of clock and watch-making to one harmonious whole, expressed in English measures and weights, and intelligible to every reader.

I have spoken with some zeal upon the value and usefulness of the Sliding Gauge, not as an invention of my own, since it is at the least 50 years old, but because without its assistance I could never have collected the intentions of the past great men, and have reduced a description of their discoveries, works, and practice to such an intelligible form that profitable advantages may be derived from them.

There is also another gauge of considerable importance, viz., my Universal Adjusting Rod, by which the force of the mainspring is discovered that is due to the barrel according to its cubical contents ; and this force, when reduced to its hourly expenditure at the centre pinion for one turn of the great wheel, determines the correct weight and diameter of the balance for any given velocity, that is to say, for a given train and arc of vibration. Here we have the two great horological problems :—

1. Given the cubic dimensions of the barrel and its hourly expenditure at the centre pinion for one turn of the great or fusee wheel, to find the weight and diameter of the balance ?

2. Given the diameter and weight of the balance, the length of arc and number of vibrations required to be made per minute, to determine the dimensions of the barrel that shall contain the requisite power to keep the piece going any determinate number of days or hours with once winding.

These are mere extracts from the fifth manuscript edition of my new series "Constructions of Horology."

Space prevents my referring at greater length to the subject of the inventions of the 18th century, when the minds of men were so eagerly bent upon mechanical discoveries. A clever man might then easily stumble upon new and valuable principles, like as, in new countries of great mineral wealth, where you have but to use your axe to discover the ore ; but the case is different when that country's hills and valleys have been explored for a thousand years, then you are almost sure to be labouring in trodden paths and abandoned mines. So with science, in which, as it approaches its zenith, it is difficult indeed to discover new principles ; and therefore one ought to be provided with a good chart, in the shape of a thorough knowledge of the historical literature of the art, or you may waste a life-time in making researches which have long ago been tried, condemned, and laid aside. Many men of great talent have wasted a valuable life-time in this way ; whereas how valuable might have been their services, had they known the high state the art had arrived at, and what was still deficient to effect its final perfection !

CHARLES FRODSHAM.

84, Strand, July, 1860.

DESCRIPTION OF A

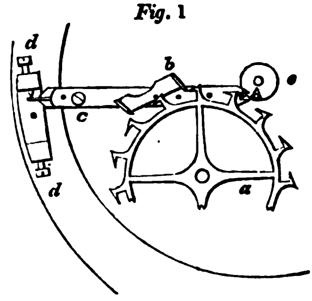
DETACHED LEVER ESCAPEMENT

EMBRACING THE PRINCIPLE OF

GRAHAM'S HORIZONTAL WHEEL.

The watch from which the annexed diagrams were taken bears the name "J. LEROUX, Charing Cross, London." We have been kindly favoured by the Clockmakers' Company with the opportunity of investigating its principles, and with the authority of the Master to publish the same. The diagrams are on a scale twice the size of the original.

Fig. 1



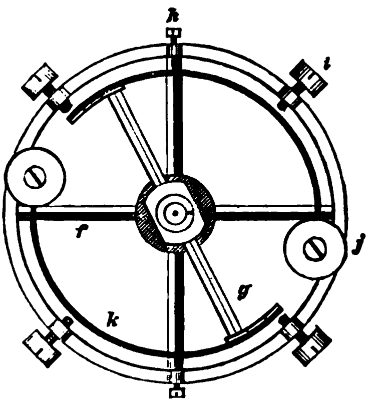
a, the wheel *c*, the lever
b, the pallets *d d*, banking screws
e, the detaining roller, below which on the same axis is another roller or disc with a ruby pin, as usual, for receiving impulse from the lever fork.

is watch has evidently been carefully ructed and well executed for a produc- the date of which is only determinable e letter *k* being the hall mark on the case.

the opposite end of the lever a thin of ruby is fitted in a notch and fixed to act equally against the points of banking screws *d d*, the stone being set separate piece, attached by a screw to ever. A similar plan is adopted at the g end of the lever, a small piece on one being formed as the fork for the impulse, the other small piece being formed as int or guard to correspond with the ning roller.

e pallets are of unusual form. The l being cut in the manner of an ordinary ontal wheel, is perfectly flat on both sides, eeth having no upright stems; it is of ered steel, and the wedge of each tooth tion passes through the centre of motion e pallets, the steel part of which, inclu- a short axis above and below, is made entire piece, with a passage transverse e axis cut through its whole length ient for allowing the wheel to pass ; at each end of this cutting a ruby ng stone is fixed, at an angle suiting the , the edges being finished as cylinder , the whole impulse is given by the l. The pallets are of equal radius, and ace only two teeth of the wheel.

Fig. 2.



e compensation balance of this watch very peculiar construction. The rim entire circle of steel crossed into four , very light, as at *f* (*fig.* 2). Midway een the arms are left four solid pro- ns above the upper surface, for receiv- the four mean-time screws, as the one ed *i*; over this rim of four arms, and he upper portion of the balance axis is fitted (friction tight) a moveable steel bar of two arms to the outer end of each of these two arms are fixed portions of circular laminæ, like the limbs of an ordinary compensation balance, the laminæ being firmly attached to the arms by two screws in each; at the acting end of each laminæ is a circular flat weight fixed by two screws.

From the outer rim as before described are two other projections for receiving two small check screws *h*; these are made to come in contact with the brass or outer surface of the laminæ, keeping the same slightly in tension by the set of the screws inward. Adjustment for compensation in this balance is effected by moving the two-armed bar forward or backward by pliers applied to the flatted sides of the bar. This motion of the bar causes a different part of the laminæ to bear against the screws *h*, thereby lengthening or shortening the effective compensating length.

It appears that this arrangement embodies the principle of an auxiliary check as employed in some other balances for correcting extremes of temperature.

HOROLOGICAL IMPROVEMENT.

To the Editor of the Horological Journal.

Sir,—Permit me to thank Mr. Charles Frodsham for his interesting article in your last number, and I hope that he will shortly publish the Tables that he has promised. I trust also that his example will be followed by other practical watchmakers, who would do an essential service to our art by contributing to your pages their individual experiences; for there must exist an immense amount of interesting and technical knowledge in the several departments of horological pursuits, the diffusion of which your journal offers a ready means of accomplishing. See, for example, what strides photography has taken since the establishment of a Photographic Journal; but I fear we must not expect so many practical contributors to your columns, for this reason,—that in photography a great proportion of those who practise it do so merely for the love of their art, whereas with horologists it is mainly a matter of business.

With all due deference to Mr. Frodsham, I hope that a perfect Compensation Balance is more likely to be discovered than the squaring of the circle, otherwise our chances are rather remote! Our requisition is now reduced within a very narrow compass. It is this,—that a balance should be invented in which the weights approach and recede

from the centre in a geometrical ratio; in other words, that they should approach the centre in an *increasing* ratio for *equal* increments of heat. This appears a simple problem in words, but it has not yet been solved. Mr. Loseby and Mr. Hartnup have both endeavoured to accomplish it; they have gained a step in advance, but have not fully succeeded. We want a balance as simple, as little liable to derangement, and as easily adjusted as an ordinary compensation balance, but yet fulfilling the above conditions.

Some time since we had a discussion on the fusee in respect to watches; I have now a few words to say on the same subject as regards clocks. I have to complain of the very unscientific principles on which the ordinary spring dials and clocks are usually made in England.

Take one of the twelve-inch spring dials, such as we see in shops, offices, and (I am sorry to say) at many railway stations. What can be worse? A short pendulum with a light bob, and a spring (ah! such a spring, too!) as the motive power. Now, substitute a weight for the spring, put a long pendulum with a heavy bob, and—rough and common as the thing is made—it will vary only as many seconds as it formerly did minutes. In all matters relating to commerce the consideration of the three little letters £. *s*. *d*. must be introduced, and in reply to the above statement it may be said,—"That is very true; we always do apply a weight and a long pendulum to our astronomical and best clocks, but these dials are constructed for cheapness, and you would make them so much more expensive." Now, this I deny. A cast-iron weight with a pulley sunk into it, cannot equal the cost of a barrel and mainspring, and a tail twelve inches long cannot add many shillings to the price of the case. Then, if without increasing the cost we can improve the clock, why not do so? I have now weight dials going excellently, with a drop for the weight of only nine inches, for eight days. Where expense or space on the wall is not taken into consideration, of course an increased length of fall is preferable, as it allows a longer pendulum. In portable and ornamental clocks for the mantlepiece, this is impracticable; but I say, that all mural clocks—such as office, railway, and hall clocks—should be made with a weight for the motive power. For ornamental hall clocks, the bracket and case should be made entire, the bracket being hollow for the fall of the weight. In striking clocks it is better to use a mainspring for the striking part, as there is scarcely room enough for two weights. In the latter case a going barrel should be used, for I do not suppose that even the advocates of the fusee for flat watches would be so far prejudiced as to insist upon a fusee for the striking train.

I have many other observations to make on similar subjects, but I fear that I have so far trespassed on your space that I must reserve them for a future opportunity.

I am, Sir, your obedient servant,

R. Webster.

74, Cornhill.

REMARKS ON Mr. FRODSHAM'S PAPER IN No. 23, BY CAPTAIN LONG.

To the Editor of the Horological Journal.

Sir,—In No. 23 of the Journal is a letter signed "Charles Frodsham, 84, Strand, London;" the contents being of a contradictory character, deserves reviewing throughout, and comparing one passage with another. He states that it would be interesting to submit my balance to the usual tests; the balance of Mr. Cole he condemns as being one of John Arnold's early plans, and discarded by him. Now, my balance and Mr. Cole's are precisely on the same principle, the only difference being in the arrangements; and here I must stop, and, in justice to Mr. Cole's talent, honestly declare that the arrangements in his balance are superior to my own. Besides, I deny that Arnold ever made known the principle; that he endeavoured to get compensation by other means is evident, but his plans were different entirely.

Here, again, is inconsistency: "He must be a bold man who attempts to construct a new chronometer balance, the present Arnold balance being perfect for all practical purposes;" he then immediately declares it to be in error, and says, "A perfect chronometer balance is the only thing to be discovered, and that it will be a golden feather in the cap of the chronometer maker who discovers it."

He also confines the Arnold compensation balance to a range of 30 degrees of temperature, and goes on to say that a ship's cabin seldom exceeds 87 degrees. Now I say, he ought to know from authentic records, that in our own climate we sometimes have the thermometer at 20 degrees below zero, Fahr.; and at a spot not within the polar circle, the cold is so intense that mercury is solidified, and can be wrought with the hammer. Is he aware that the reading of the thermometer in a ship's cabin in harbour at Calcutta, on evenings, seldom ranges lower than 120 degrees Fahrenheit, and is frequently higher;

on the western coast of Africa it is hotter still.

He complains that I did not describe my chronometer. Had I done so, it would have been an insult to those in the trade who are supposed to know their construction; besides, I had only to explain my balance. It is the original one,—it answered my expectations, and is certainly capable of improvement in the arrangement of its parts, the principle remaining the same.

I will just ask a question,—Why should not the discovery of a perfect chronometer balance or any other useful production be as acceptable from a non-professional as from one engaged in the trade? From whom have we derived the greatest and most important discoveries and improvements?

Before those who are generally engaged in the manual operations of any mechanical trade can make improvements, they must educate themselves. How many are there who do a thing, and do it well too, merely because they have been taught to do it; ask them a reason for its being so, they do not know if it is right, or whether there is not a better form or system.

I should have stated, that one of my chronometers bore the name of Earnshaw, and one of Berthoud; sometimes we had on board one by Le Roy, but never took the latter northward.

I beg to observe, that I know nothing of Mr. Charles Frodsham; it is only his letter with which I have to deal, that being public property. One word more:—He says, he does not know what experience I have had. Probably not so much as himself in the construction of chronometers, but perhaps I have put them to more severe tests than he has ever had the opportunity of doing.

I beg to claim your indulgence for occupying so much of your valuable space, and remain your obedient servant,

S. Long.

Kingston-on-Thames, July 9th, 1860.

Mr. COLE IN REPLY TO Mr. FRODSHAM.

To the Editor of the Horological Journal.

Sir,—I embrace the opportunity of making a few observations in reply to the remarks made by Mr. Charles Frodsham relating to me, and published by him in No. 23 of the Journal, wherein he evidently attempts to lessen the value of my judgment as regards marine chronometers.

That sufficient grounds for any such remarks exist is simply absurd, as it is well-known that to produce the results mentioned in reference to pocket chronometers as portable time-keepers, there are far greater difficulties than any that arise with respect to marine chronometers as comparatively stationary instruments, the former being subject to change of position and other influences, while the latter are treated with greater care, and constantly kept in the most favourable position for correct performance.

I submit, though my attention has heretofore been chiefly directed to chronometric watches and pocket chronometers, I have not lost sight of marine chronometer principles; some interesting improvements relating expressly to this department have long been subjects of careful study, as evidenced by two patents* taken out by me thereon, the latest of which I am now carrying into execution: the results will shortly be ascertained.

Mr. Frodsham further states, that "the balance which Mr. Cole calls a non-resisting balance is one of John Arnold's early plans." He would do well to bring forward such a balance, or an original description of it, in support of such statement. It would also be interesting to know the facts intended for the benefit of chronometrical science and "his friend Mr. Cole and others," and that he will make proper use of the admitted valuable "hints and information" he has received.

That, after requesting my name to be withdrawn from Mr. Frodsham's paper, he should have thought it either just towards me, or judicious on his own part, to subject his sincerity as a friend, or his early competency as a watchmaker, to being questioned or touched on, somewhat surprises me, knowing as I do his extreme sensitiveness on both those points.

Questions of personal merit, I think, should not be carried to the extent of publication in a scientific journal; such manifestation of private feeling is not consistent with the higher purpose of such a work or the dignity of a liberal mind.

Mr. F. should also have considered the opportunity he would afford to me of justly reverting to circumstances and facts relating to "high-class watchmaking," prominently set forth in 1851, specimens of which were pronounced "the flower of the English school." This slight allusion, I think, will be so well understood as to prevent further remarks of like tendency to those I complain of.

The plan of the "Non-resistent Compensation Balance," described as *fig.* 2, in No. 22 of the Journal, was shown and explained by me to Mr Frodsham some time before the cor-

* Dates 1821, 1859.

respondence given therein took place. I regret that the subsequent publication of this balance, and of the balance of Captain Long, with his experience of the results, should have occasioned the author of the article in question so much uneasiness.

I will only add, that I have no doubt whatever, that the making a chronometer to keep a rate uniform through the widest range of temperature, under extremes of climate will eventually be successfully accomplished, by simple means, and without any increase of expense.

I am, Sir, your's very respectfully,

James F. Cole.

29, Devonshire-street, Queen-square,
July 26, 1860.

Note.—It is quite a mistake to connect the name of Arnold with the ordinary compensation balance otherwise than as adopting Earnshaw's method of fusing the brass upon the steel; it therefore should be called, what it really is, "the Earnshaw balance." J. F. C.

EXPANSION OF METALS.

To the Editor of the Horological Journal.

Sir,—In the abstract of a paper "On the Expansion of Metals," inserted in No. 23, it is not mentioned that the thermometer used in the experiments was the Centigrade. The 100° referred to are therefore equivalent to the interval between the freezing and boiling points of the Fahrenheit scale.

Your's respectfully,

G. C. Lowe.

Manchester, July 3d, 1860.

Clock and Watch Makers' Asylum.—On Monday the 23d of July, a Special General Meeting of the Subscribers to this Institution was held at the Crown Tavern, Clerkenwell-green, for the purpose of electing three Inmates for the Asylum—namely, two men and one woman. The chair was was taken at seven o'clock by Mr. George Moore. At nine o'clock the Chairman declared the ballot closed; and the Scrutineers having returned in about twenty minutes afterwards, the Chairman announced the following as the result of the election:—Mr. James Haines, 1465, and Mr. Burwash, 1072, as the successful males; and Mrs. Martha Andrews, 2155, the successful female candidate. The following votes were recorded respectively for the unsuccessful applicants:—Males: Richard Gee, 649; Charles Boyce, 476; Henry Ducker, 457; John Barlow West, 327; and Thomas Newman, 162. Females: Charlotte Platt, 227; and Louisa Ansell, 23.

EQUATION OF TIME TABLE

For August, 1860.

Day of the Week	Day of Mnth	At Apparent Noon — Equation of Time to be *added* to Apparent Time.	Difference for One Hour.	At Mean Noon — Equation of Time to be *subtracted* from Mean Time.
		m. s.	s.	m. s.
Wed ..	1	6 1·07	0·172	6 1·09
Thurs.	2	5 56·94	0·197	5 56·96
Fri. ..	3	5 52·20	0·222	5 52·22
Sat. ..	4	5 46·88	0·247	5 46·90
Sun. ..	5	5 40·95	0·271	5 40·97
Mon...	6	5 34·45	0·295	5 34·48
Tues ..	7	5 27·38	0·319	5 27·41
Wed ..	8	5 19·73	0·343	5 19·76
Thurs.	9	5 11·53	0·365	5 11·56
Fri....	10	5 2·76	0·388	5 2·79
Sat. ..	11	4 53·44	0·410	4 53·48
Sun. ..	12	4 43·59	0·433	4 43·62
Mon...	13	4 33·19	0·455	4 33·23
Tues ..	14	4 22·26	0·477	4 22·30
Wed ..	15	4 10·80	0·499	4 10·84
Thurs.	16	3 58·83	0·520	3 58·87
Fri. ..	17	3 46·34	0·541	3 46·38
Sat. ..	18	3 33·35	0·562	3 33·38
Sun. ..	19	3 19·86	0·583	3 19·89
Mon...	20	3 5·88	0·603	3 5·91
Tues..	21	2 51·41	0·622	2 51·44
Wed ..	22	2 36·48	0·641	2 36·51
Thurs.	23	2 21·10	0·660	2 21·12
Fri ...	24	2 5·26	0.678	2 5·28
Sat ...	25	1 48·99	0·695	1 49·01
Sun. ..	26	1 32·30	0·712	1 32·32
Mon...	27	1 15·21	0·728	1 15·22
Tues..	28	0 57·74	0·743	0 57·75
Wed ..	29	0 39·91	0·758	0 39·92
Thurs.	30	0 21·73	0·771	0 21·73
Fri. ..	31	0 3·22	0·784	0 3·22

TO CORRESPONDENTS, &c.

All Communications for this Journal should be addressed to the Editor, *at the Office,* 35, Northampton Square, Clerkenwell.

N. B. Advertisements to be inserted in the Journal must be received before the 25th of the month.

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END OF VOLUME II.

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THE

HOROLOGICAL JOURNAL:

THE

Special Organ

OF THE

BRITISH HOROLOGICAL INSTITUTE.

VOLUME III.

LONDON:

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AUG. 1, 1861.] 1861.

The Horological Journal.

VOLUME III.

SEPTEMBER 1, 1860.

TO OUR READERS.

THE appearance of the present Number (being the first of a Third Volume of our Journal) again affords us the opportunity of addressing to our Subscribers, in accordance with established custom, a few remarks—retrospective as regards our efforts hitherto, and anticipative of our future progress.

The success of the Journal in a financial point of view is sufficiently attested by the last half-yearly Report certifying its then rapidly increasing sale. Nor has subsequent experience failed to realize the hope we ventured to express in our last yearly address, that the HOROLOGICAL JOURNAL would progressively attain a certain position in the scientific world, and become valuable as a work of reference, as well from the general features of interest and information evinced in the papers supplied by its contributors, as from the more practical and scientific treatises occasionally appearing in its pages.

As highly valuable and useful instances of this species of contribution, we may refer to the Lecture by Mr. J. F. COLE, reported in Vol. I. p. 153, on the principles relating to the laws by which the diameter and weight of balances and the strength of balance springs for the various trains are determined, and to the Tables (in No. 24) for apportioning the diameter and weight of the balance to the velocity, furnished by Mr. CHARLES FRODSHAM,—a production bearing evident proofs of considerable research and great practical observation.

A leading feature of the HOROLOGICAL INSTITUTE has, since the period of our last address, received an important developement—we allude to the Museum, which has been enriched by many valuable presents.

The Library also has been augmented by the receipt of gifts ; including a collection of the " Rates of Chronometers forwarded for trial to the Royal Observatory at Greenwich," from 1840 to 1859,—a presentation kindly made by the Astronomer Royal.

The progress of the CLASSES lately established for the study of Geometry, Mechanical Drawing, and Art Decoration of Watches, has been highly satisfactory ; as evinced by the very promising productions of the students attending them.

As regards the Lectures and Discussions, we may mention some very interesting arguments which have been held on various branches connected with Horological Science, and which have been the means of eliciting a variety of powerful and practical opinions from the members present. Here we may more particularly allude to a most valuable Lecture on Mineralogy as applicable to Watch Jewelling, kindly volunteered by the eminent Professor TENNANT, and the reception of which by the hearers fully testified the sense they entertained of the importance of the subject as connected with the practical operations of the Trade.

With these observations we have thought it not inopportune to preface the Third Volume of the Journal, in the full anticipation of a constantly increasing success ; to the realization of which, we may add, no effort on our part as regards the Editorial department shall be wanting, relying as we do on the support of the Members of the Institute in furthering the objects of an undertaking, which, promising indeed as it may now, we trust, be deemed, is still in the main dependent on the zealous co-operation of the body of the Subscribers.

THE BRITISH HOROLOGICAL INSTITUTE.

CLASSES FOR GEOMETRY, AND MECHANICAL AND ORNAMENTAL DRAWING, AS APPLIED TO HOROLOGY, CONDUCTED BY Mr. W. J. HOARE.

The satisfactory progress evidenced by the Pupils in the first quarter now expired has induced the Council to offer encouragement to those showing the most assiduity by awarding prizes; three of which will be given at the end of the present quarter.

A few more names are required to establish these Classes on a sound basis; and the Council take the opportunity of the re-opening of these Classes to urge Members and the Trade to aid this most desirable object.

All particulars as to membership may be obtained at the Institute.

By order of the Council.

SPECIAL GENERAL MEETING.

On Thursday the 23d August, a meeting of the members was held at the Institute, for the purpose of electing a Vice-President, a Treasurer, a Trustee, and one member of the Council, and for the consideration of three motions of which notice had been given.

The chair was taken by Mr. KLAFTENBERGER.

Mr. MYLNE, the Honorary Secretary, read the notice convening the meeting.

The following gentlemen were elected Scrutineers:—Messrs. Hartshorn, Bishopp, and Coward.

Mr. CLIFTON wished to know if reports of the proceedings of the Council could be published in the Journal; also if Mr. E. D. Johnson would accept office if elected Vice-President. The Chairman intimated that the usual notice of such a motion for publishing the proceedings of Council was necessary; and that he could state, as to the nomination of Mr. E. D. Johnson, that he intended to stand if elected.

The Secretary then read the motion of Mr. Hux, which was as follows:—"That Ten per Cent. of all moneys received from and after the 24th June, 1859, be set apart to form a fund, to be named 'The Institute College Fund;' the same in the names of three members of the Council to be deposited or invested from time to time, so as to bear interest, such fund to be for the special object of enabling the Council in a few years hence to purchase premises for the use of the Institute; and that no appropriation of 'The Institute College Fund' be made without each member of the Council having at least nine days' notice of such intended appropriation, the notice to be considered duly served upon each member of Council if sent by post, or otherwise delivered at his last-known place of abode."

Mr. JACKSON said that the amendment or rider to that motion which he had to propose was, "To set apart Five per Cent. of all moneys received from and after Christmas next, to form a fund to be named 'The Institute College Fund;' the said fund to be invested from time to time in the names of three members of the Council, so as to bear interest—such fund to be for the special object of enabling the Council a few years hence to purchase premises for the use of the Institute. No appropriation of this fund to be made without each member of the Council having at least nine days' notice of such proposed appropriation; the notice to be considered duly served upon each member of the Council if sent by post, or otherwise delivered at his last-known place of abode; and that no appropriation, except to the purposes of the Institute College Fund, be made of any donation given specially to this fund." The motion of Mr. Hux had on a previous occasion been favourably received by the meeting, and the object of the amendment was only to reduce the amount of the reservation. There could be no objection to the setting apart Five per Cent., not to commence until Christmas next. Mr. Hux had given his full consent to the amendment, which did not in any way alter the principle of the resolution. Its practical object was to prepare for a rainy day; to do that which every prudent man, and consequently every prudent body, would desire to do—namely, have something in store; to raise the nucleus of a fund which liberal-minded men might hereafter largely increase by donations, provided they had a proper guarantee that it would be devoted to that particular object of the College. Two or three gentlemen had already intimated their intention of giving towards it; in fact, he had heard a considerable sum named as likely to be contributed if the proposition should be adopted. He did not mean to say that the motion was not open to objection, and if any gentleman had any, he hoped that he would state it; but he trusted that the principle laid down would not be taken exception to. He hoped that the time

would soon arrive when not only the Horological Institute, but the two or three other institutions of the trade, would have a fitting room wherein to hold their general meetings; and that they should see Science, which was power, combined with Benevolence, which was heart, and that they might meet together for the two objects in friendliness—a spirit which perhaps questions of mere scientific interest did not always tend to bring about.

Mr. Guinand seconded the motion.

Mr. Walters had but one objection to it. He looked upon the whole of the members of the British Horological Institute as a proprietary, just the same as the shareholders in a joint-stock bank. Such a fund as that proposed to be set apart for the erection of a college was precisely similar to the reserve fund of such a company provided to meet future contingencies of the bank. But there was a provision that it should not be touched unless the whole proprietary consented to the act. They could not do better than add a clause to that effect to the amendment, which was otherwise admirable in itself.

Mr. Jackson assented to the suggestion which was subsequently added to the amendment in the following words:—"No appropriation of these funds to be made, except with the consent of a general meeting of members."

Mr. Trewinnard was opposed to the motion on principle. The Council had been invested with powers to deal with funds belonging to the members contributed for specific purposes, and scarcely, perhaps, one-tenth of such members were present. What were those trusts? They were comprised in the second rule:—"To promote the cultivation of the science of horology, and to foster the various branches of arts and manufactures arising out of it. Its views are directed to the following objects—First, the formation of a library, reading room, and a collection of tools, models, and machines. Second, the delivery of lectures and the reading of original papers connected with the art of horology. Third, the formation of classes for the study of the various branches of knowledge connected with the theory and literature of horology. Fourth, the encouragement of merit, either in invention or workmanship, by suitable rewards and marks of distinction." Not one of them, with the exception of two or three lectures, gratuitously given, had been carried out. The money was contributed for those purposes, but if the present resolution passed they would be virtually declaring that it should not be so appropriated. He was very much pleased with the amendment, in so far that it greatly mitigated the evil of the original motion, which proposed to set apart for the purpose Twenty per Cent. of the income of the Institute. (Cries of "No, no; only Ten.") He begged pardon; he hoped no gentleman who was not fully aware of the facts would contradict him. The first motion proposed to the Council was for Twenty per Cent., and was, moreover, in its operation, to be retrospective from the formation of the Institute. After some discussion, Ten per Cent. was adopted, and the retrospective operation was abandoned. Then it was found that the Council had no power to part with money in the manner proposed, which could only be done by the subscribers in general meeting assembled, and therefore it was brought before the whole body. But even at the Five per Cent. it would take away 30*l.* a year of their annual income,—a sum which had not been saved during that year, and would not be saved in the next. They might call it the "College Fund" if they liked, but the Council would have to take it away for other purposes. The notion of the Institute having a building of its own was admirable, and nobody could say a word against it. He was as great an advocate for carrying it out as any one, the only difference between himself and the supporters of the motion being as to the source from whence the money was to be obtained. He would move, as an amendment, "That the motion relative to the necessity of a College fund be referred to the Council, to devise the best means of procuring the required sum to cover the expenses without touching the funds of the Institute, and to report upon the same at the next general meeting." He believed that a separate fund might be raised by the Council, which might appoint a Committee to devise means to raise the money, as well as to ascertain the cost of the building, and other particulars. Several subscriptions likely to be had had been mentioned to him, and he had stated others. The necessary fund might be raised without touching a farthing of the income of the Institute.

Mr. Cole, in seconding the amendment, said that he was of precisely the same feeling as Mr. Trewinnard. The funds of the Institute should be entirely untouched, and the College should be raised by donations, and from other sources.

The amendment was supported by Messrs. Watson and Marriott and opposed by Messrs. Clifton and Brooks. It was then put, when there appeared for it, 15, against, 17. The original motion was carried by 22 votes.

Alteration in the Mode of Electing the Treasurer.

Mr. Gordon then moved, "That the following alteration be made in Law VIII.:—'That the Treasurer shall be elected yearly at the General Meeting for that purpose, by a majority of the members present, instead of being balloted for, or proxies allowed, so that the office be considered permanent, subject to the approval of the members at the Annual Meeting.'" As the office of Treasurer was one of considerable trust and honour, he thought that a gentleman once appointed to it should not be deprived of it for any trivial cause. If he did his duty, he ought to be retained in his position.

Mr. Watson seconded the motion.

Mr. Marriott saw very little use in discussing a motion which was at the time the subject of a ballot. At the same time he was always very jealous of interference with the laws of the Institute, which, if worth anything, should not be tampered with. They should not be altered just to please individuals. Why should an exception to the rule of electing by ballot be made in the case of the Treasurer? No doubt he would be continued in the office if he was a fit person for it.

Mr. Brooks wished to know whether the resolution had been proposed merely to please Mr. Webb?

Mr. Walters considered it impossible for the members to vote for the motion on account of its obscure wording, which defeated itself. It proposed to render the office permanent, and yet to submit it to annual election by show of hands. The resolution not only involved a contradiction, but it aimed at what he considered a most mischievous principle, amounting to a disfranchisement of the members, who, although competent to vote by ballot upon every other question, were not supposed to be so upon that. A man who conducted himself properly in the office would be continued in it, but if his conduct was liable to censure he would be removed. Any right-minded man, conscious of the purity of his motives, would consider the submission of his conduct to the ballot as a triumphant verdict in his favour.

Mr. Clifton, when he read the motion, felt as though he was walking round a pond. It was full of blunders, and he could not agree with it. A meeting might be packed. Such a mode of election would shut out the country members from voting.

Mr. Jackson opposed the motion, which ought to have been previously submitted to the Council. He objected to alter a law to please anybody.

For the resolution, 39; against, 57.

Abolition of the Office of Honorary Secretary.

Mr. Brooks then moved the following proposed alteration of laws:—"To enable the Council to appoint the Secretary under Law XIII., it is resolved that the words Honorary Secretary be erased from the laws." It was easier to hear another speak than to speak correctly one's-self, and he therefore claimed the indulgence of the meeting. There was some misconception as to the nature of the resolution, which he was desirous of removing. He was anxious to avoid anything offensive either to gentlemen present or absent. The nature of the duties of Secretary should be properly defined, and the Council should have the power of electing that officer, which was essentially its own. He had no wish to deprive the Honorary Secretary of his title. There was nothing in the resolution to prevent the Council electing Mr. Mylne to the office on the morrow evening. The motion merely gave the Council power to appoint their own "servant," a word which he believed correctly described the office. It was wrong for such a man to be elected by a body of men living at a considerable distance, and who knew nothing of the abilities of the candidate. He had no desire to alter the laws, and therefore he proposed to effect the object by simply erasing the words "honorary secretary" from Rule XIII. There was nothing to prevent the meeting determining that the alteration should not take place until Christmas next, or until a vacancy occurred in it. He had offered at the Council to introduce words to that effect the moment it was mentioned that the resolution as it stood was personal to one gentleman. He simply wished the members to affirm a principle which he believed was calculated to promote the interests of the Institute. It was said they could not afford to pay for an efficient Secretary. Mr. Mylne had frequently informed them that he could not possibly continue his services; and he (Mr. B.) was of opinion that when it was vacant it would be better to appoint to it a person unconnected with the trade. It did not matter, however affable and kind an honorary Secretary might be, there was an old saying, that two of a trade could never agree. However disposed he might be to give satisfaction to all parties, there would be sure to be some who would oppose him, and it would be better to appoint a gentleman who had no feeling with any party, and who would have no interest but that of endeavouring to bring together all parties. But it was said that the Institute could not afford to pay 150*l.* or 200*l.* a year for such a Secretary; it was not intended that they should do so. It was well known that there were spirited gentlemen on the Council who would give their services to assist such an officer, without creating anything like jealousy—such as Mr. Stoddart, who would assist in the department of accounts, and Mr. Guillaume and Mr. Klaftenberger in conducting the foreign correspondence. Such a Secretary might employ himself in collecting subscriptions, the commission upon which would make up for the deficiency of a smaller salary. He would read a letter he had received from Coventry, approving of the change and at the same time warmly eulogizing the present Honorary Secretary.

Mr. Bruton seconded the resolution.

Mr. Walters thought it desirable to have a Secretary appointed in the same way as the other officers, and that the present dual character of the office should be abolished; but he had some doubt about the direct tendency of the motion, because, if it was not wished to dispossess Mr. Mylne, why erase from the laws the words "Honorary Secretary?" It was another thing to have a servant directly responsible to the Institute. He agreed with Mr. Brooks as to the advisability of having a secretary elected the same way as the other officers. He desired to see the offices of the two secretaries centralized. But the resolution of Mr. Brooks, although professing to aim at the same object, created great confusion, because, as the saying was, too many cooks spoiled the broth.

The Chairman said that there was very little foreign correspondence to conduct, and therefore that was of no consequence. He should like Mr. Brooks to find a properly qualified Secretary unconnected with the trade. If he looked about until next Christmas he would be unable to do so. He (the Chairman) had regularly watched the proceedings of the Council, and he knew that the Honorary Secretary had a great deal of work to do, which he did most efficiently. The present Assistant Secretary not being a watchmaker did not know the trade terms, and was consequently obliged frequently to refer to the Honorary Secretary to answer letters. Mr. Trewinnard had shown that the Institute had no money with which to pay an efficient Secretary an adequate salary. If they found a gentleman kind enough to do the work, surely they ought to give him the title of "Honorary Secretary," which was given to such an officer in all other institutions. Law XIII. spoke of all "paid officers and servants," and the Honorary Secretary did not come within that category.

Mr. Ganney objected to the motion, because it took the election out of the hands of the members.

Mr. STRAHAN opposed the motion. Mr. Mylne had performed his duties to the satisfaction of the Council and members, and the motion was offensive on account of its ungrateful nature.

Mr. MARRIOTT regarded the office of Honorary Secretary as essential to the Institute. If gentlemen could be got to work for nothing, they should do so; they certainly were the best workmen who had plenty of work to do. He could not understand why they should dismiss an honorary secretary who had performed his duty most efficiently. The funds would not afford the services of a well-educated secretary. The Council would have a right to complain of Mr. Mylne if he had not performed his duties properly. Mr. Brooks wished to bring in the services of Mr. Stoddart. Why? That gentleman had accused the Secretary of not doing his duty, and then a gentleman half an hour afterwards proposed a vote of thanks to him, and said he had performed his duty most efficiently. Mr. Stoddart was quite as likely to take offence if the Honorary Secretary was dismissed and a paid servant was employed.

Mr. BROOKS rose to order. He had abstained from personal allusions; but if any such were made, he should be obliged to defend himself by stating the real facts of the case.

Mr. MARRIOTT replied that, if there were any facts which ought to be stated, he was a great advocate for their being laid before a meeting of the members, who, along with the trade generally, ought to know the attendances of the committees, and who did the work of the Institute. He was disgusted at a late Council meeting to hear a gentleman offer to take his oath that he had not spoken against a particular person, and another gentleman contradict him and say that he had. Everything should be done above board, and no gentleman should be ashamed of what he was doing.

Mr. JACKSON deprecated personal observations concerning gentlemen not present. He felt that the question required more consideration before a decision was arrived at upon it. Mr. Brooks had expressed his willingness that the change should not take effect until the next vacancy in the office; that observation should have taken anything like a sting of personality out of the motion. Mr. Mylne was a member of the Council as well as Honorary Secretary, and might fall back on his right and say that he was appointed by the members. It was wrong to apply the word "servant" to the office of Honorary Secretary. He felt for the position of Mr. Mylne, at the same time he saw the necessity of harmonious working in the Council.

Mr. SHALCROSS remarked, that it was utterly impossible for any one, month after month and week after week, to please every one of twelve or twenty gentlemen. It was no matter who it was; if the gentleman did his duty, it was immaterial whether he was paid or not. In the state of their finances, if they could get the duty done efficiently without pay, it would be preferable.

Mr. WATSON thought that the present motion seemed a very strange proceeding. They might as well ask the members to give up the right of electing the president or the vice-presidents, as to place in the hands of the Council the appointment of Honorary Secretary. He was sure that there was no man in the Institute who had done more for it than Mr. Mylne had. The motion was an insult to the Honorary Secretary. It would take from him the title "Honorary." Mr. Mylne had given up his seat at the Council to be elected by the members to that office. If the word was struck out, he could not retain his seat for one day, and the Institute would lose the benefit of his services.

Mr. TREWINNARD was quite at a loss to understand the meaning of the resolution. No one knew better than Mr. Brooks the fact, that for the manner in which Mr. Mylne had performed the duties he had received the thanks of the Council. Mr. Brooks had been as forward as any one in recognizing those long services and arduous duties; and now, all of a sudden, he proposed to strike out the word "Honorary" from his title. Such a proceeding seemed most inconsistent, and he (Mr. T.) could not imagine why it was done. Mr. Brooks knew that the Institute had not funds with which to pay for the services of an efficient Secretary. He knew that Mr. Mylne had served the Institute as Honorary Secretary *pro tem.* for almost six or eight months before he was elected to the office in last June. No sooner was he thus appointed—about three weeks ago—than Mr. Brooks came forward with a motion to take away all the honour from the office. Having praised the services of Mr. Marriott, Mr. Adams, and Mr. Mylne, all of a sudden Mr. Brooks turns round and takes this step. Mr. Mylne had been most punctual in his attendance; he (Mr. T.) did not think that gentleman had been absent from any one meeting of the Council, either when acting *pro tem.* or since his regular election. It was known how arduous the nature of the duties were—that Mr. Mylne had to be at the office several hours a day.

Mr. MYLNE begged Mr. Trewinnard not to mention these things. He was ashamed really of having done it.

Mr. TREWINNARD felt it right to inform the members of the Institute that they were under a heavy debt of gratitude to Mr. Mylne. Besides that, an attempt was being made to deprive them of a great and important right. He called upon them not to trust the Council, nor any body else, to do for them what they could do for themselves. Who ever heard of such a term as "Honorary Secretary to the Council?"

Mr. BROOKS begged pardon—the first of those officers was Honorary Secretary to the Council.

Mr. TREWINNARD.—The first Secretary was paid £50 per annum. Mr. Brooks very strongly advocated the removal of Mr. Breese on several grounds, one of which was, that the Institute could not afford a paid Secretary, and that it could get the same duties done gratuitously. Now he wanted to reverse that determination. If they decided in favour of the motion, could they expect Mr. Mylne to be in office to-morrow morning?

Mr. BROOKS enquired what Mr. Myddelton was paid for?

Mr. TREWINNARD.—As clerk and assistant to Mr. Mylne.

Mr. BROOKS in replying, claimed the protection of the meeting. He had stated at the commencement of his remarks that this was not a personal question. It had nothing to do with turning out

Mr. Mylne, because the members had it in their power to defer the operation of the resolution until next Christmas. With regard to payment, again, an unfair advantage had been taken of what he said. He had stated that the resolution was a measure of economy, and nothing that had been said on the other side had proved the contrary. Instead of its costing one pound more, in all probability they would receive more subscriptions through the Assistant Secretary being employed to canvass for them; so that they would be richer for his services instead of poorer.

Mr. Trewinnard denied having stated that Mr. Brooks intended to insult Mr. Mylne, but that such would be the effect of his motion.

A Member observed that it was important the question should be determined that night, without going any further.

Mr. Brooks was quite content to abide the result of the ballot.

Mr. Trewinnard said, that a vote must be taken as well.

The Chairman said, that, notwithstanding Mr. Brooks's explanation, up to the present moment he did not understand the motion. That gentleman had offered yesterday to explain it in private; but that he had declined to accede to. Mr. Brooks said that there was nothing personal in the motion, but he could only look upon it in the light of personality. If he had done the work Mr. Mylne had done for the Institute, he would not have sat and listened to such a motion; he would have found means to employ his time better elsewhere.

Mr. Brooks repeated that the object of his motion was not against Mr. Mylne, but that the Council should have the power of appointing a Secretary unconnected with the trade.

Mr. Marriott denied that any one was opposed to Mr. Mylne. If they were in the habit of tempering of steel, do let them try to temper themselves. If the Secretary was not worth being retained, then pray let them turn him out.

The Chairman said that the Honorary Secretary of an Institution was its mainspring, and if that was changed very often, it was very liable to break.

A show of hands was taken of the gentlemen who had not voted by ballot, when there appeared none for and six against the motion.

The result of the ballot was, for the motion, 54; against 38, which, together with the numbers on show of hands, made 44 against and 54 for.

The Chairman declared the motion lost, inasmuch as it required a two-thirds majority to carry it.

Result of the Ballot for Vice-President, Trustee, and Treasurer.

Vice-President.—For Mr. Crisp, 66; and Mr E. D. Johnson, 66.

After some discussion as to the right of the Chairman to the casting vote, which was denied by several members.

The Chairman said h should have given his casting vote in favour of Mr. Johnson because he had nominated him; but he would leave it to the meeting to decide.

Mr. Jackson suggested the postponement of the settlement until the half-yearly meeting.

Mr. Marriott objected to the adoption of such a course.

Mr. Crisp expressed himself delighted with the result of the ballot. Mr. Johnson was a friend of his, and no one would be more happy to see him in that position than he (Mr. C.) would; he should therefore withdraw in his favour.

After some opposition this course was adopted, and Mr. Johnson was declared elected.

Trustee.—For Mr. E. J. Thompson (unopposed), 103.

Treasurer.—For Mr. J. C. Webb (unopposed) 101.

Member of Council.—For Mr. George Frodsham, 99; Mr. Walsh, 33.

Vote of Thanks to the late Treasurer.

Mr. Brooks thought that the meeting ought not to separate without expressing its sense of the services of Mr. R. R. Hux in the above capacity.

The motion was carried unanimously.

Thanks were voted to the Scrutineers.

Election of a New Auditor.

Mr. Walters was elected in the room of Mr. J. C. Webb, disqualified as Treasurer.

Mr. Mylne proposed a vote of thanks to Mr. Farmer and the press, which was passed unanimously, and acknowledged.

A similar compliment having been paid to the Chairman, and responded to by him, the proceedings terminated.

ELEMENTARY PAPERS

ON MECHANICS AND MATTER IN MOTION.

(*Continued from page* 156.)

On the Rotation of the Earth.—The Pendulum Experiment by M. Faucault, of Paris.

The common arguments in support of the doctrine, that the earth has a diurnal rotation about one of its diameters, give to that doctrine a degree of probability so nearly approaching to absolute certainty, that the mind readily acquiesces in the reality of the phenomenon. Since the time of Copernicus the evidence for the earth's rotation has been continually increasing; but still this evidence is not of that direct and positive kind that is necessary to give to it the character of demonstration. All the other hitherto discovered planets of our system revolve on their axes, and, as might be expected as a consequence of this revolution, those of them upon which the examination can be made are seen to be flattened at their poles. It is probable, therefore, that the planet we inhabit also revolves on an axis; if so, it too may be expected to be flattened at its poles. Whether

or not this is the case, can be actually ascertained by experiments. These have been undertaken, and repeated again and again with the greatest care, and by independent and widely different means; the results all show, that the earth *is* flattened at the poles. There is thus a very high degree of probability that the earth rotates; and this is further increased by the fact, that all the phenomena of the heavens are completely consistent with the hypothesis of such a rotation; that it is, moreover, the simplest hypothesis upon which the celestial appearances can be explained; and that to attempt to account for them on any other hypothesis involves the system of the universe in such intricacy and extreme complication, that, judging from all the other operations of Nature, we cannot bring ourselves to suppose that such complex machinery should really be the "handiwork" of an all-wise Creator, when means immeasurably simpler presented themselves of bringing about the same ends.

But, notwithstanding all this, a sensible or experimental proof that the earth rotates was still wanting. Its general figure can be experimentally discovered; its superficial rotundity can be seen. It is very desirable that we should have the same ocular evidence of its rotation. A profound writer on physical astronomy has observed, that "We must, however, be content, at present, to take for granted the truth of the hypothesis of the earth's rotation. If it continues to explain simply and satisfactorily other astronomical phenomena than those already noted, the probability of its being a true hypothesis will go on increasing. We shall never indeed arrive at a term when we shall be able to pronounce it absolutely proved to be true. The nature of the subject excludes such a possibility."

This prediction of Professor Woodhouse has been falsified; we can now obtain sensible evidence of the rotation of the earth.

The idea of proving this interesting phenomenon to the senses occurred a few years ago to M. Faucault, of Paris. It was suggested to him by accidentally observing the motion of a weight suspended by a string to a high ceiling, and which by chance had been set vibrating. Some of our readers must remember the sensation produced in the scientifice world, in the spring of 1851, by the remarkable pendulum experiment of Faucault. We here propose to submit to them, without going into any minute mathematical details, what appears to us to be a conclusive and satisfactory explanation of the manner in which this experiment renders the rotation of the earth a matter of personal observation; but, as we write chiefly for the young and for those who may be supposed to be but little habituated to scientific researches, we shall previously offer to their attention a few general remarks in reference to what may be called the two great postulates of astronomy; these are the rotation of the earth, and the hypothesis of gravitation.

We speak of gravitation as a physical *hypothesis*. It is not, like a proposition in geometry, a necessary truth; nor is it an observed fact recognisable by our senses. Certain phenomena in nature are observed; they exhibit a regularity of succession, and a mutual dependence, that suggest the idea of a connecting principle and a governing law. The phenomena are seen—the proximate cause is inferred. The philosopher looks abroad upon Nature, and carefully studies the facts she presents to him, the order of their recurrence, and the measure of their intensities: he retires to his closet, and endeavours to frame a law, of which the appearances he has been studying shall be the outward expression—the practical manifestation. This is an *hypothesis*. An hypothesis, therefore, need not be more than co-extensive with the phenomena actually observed; but it is a strong confirmation of the soundness of an hypothesis when it is found that new and unexpected phenomena are equally comprehended in it, and a stronger confirmation still when such phenomena can actually be predicted. The two fundamental hypotheses of astronomy—the rotation of the earth, and the law of gravitation—have this character in the highest degree. Every new discovery in the science has only more firmly established the truth of both.

The learner will perceive that we could not with any propriety speak in this way of the truths of geometry: they are quite independent of the confirmation of experience, and hence the marked difference between physical and geometrical science. When Dr. Halley had predicted the return of the comet of 1682 in 1759, and Clairaut had computed from the hypothesis of gravitation the time when it ought to appear, its return was watched for by astronomers with the greatest interest—not from any anxiety to see the comet, but to learn how the hypothesis of gravitation would stand so severe a test; and the re-appearance of the same comet in 1835 was anticipated with like interest, solely in reference to the planetary attractions—that is, to the general theory of gravitation.

"The rude supposition of the uniform revolution of the moon in a circle about the earth as a centre, led Newton at once to the true law of gravity, as extending from the

earth to its companion. The uniform circular motions of the planets about the sun, in times following the progression assigned by observation in Kepler's rule, confirmed the law, and extended its influence to the boundaries of our system. Every thing more refined than this,—the elliptic motions of the planets and satellites—their mutual perturbations—the slow changes of their orbits and motions, denominated *secular* variations—the deviation of their figures from the spherical form—the oscillatory motions of their axes, which produce nutation and precession of the equinoxes—the theory of the tides, both of the ocean and the atmosphere,—have all in succession been so many trials of life and death, in which this law has been, as it were, pitted against Nature—trials whose event no human foresight could predict, and where it was impossible even to conjecture what modifications it might be found to need. Even at this moment, if among the innumerable inequalities of the lunar or planetary motions any one, however small, should be discovered decidedly not explicable on the hypothesis of a force varying as the inverse square of the distance, that hypothesis must be modified till it accounts for it."*

From these statements the student will perceive, that one of the two fundamental hypotheses of astronomy—the hypothesis of gravitation—is not irrefragably established, like a proposition in Euclid; nor is it a truth set at rest, once and for ever, by observation and experiment. Indeed, no physical truth can be regarded as thus unalterably fixed, like a necessary truth of geometry. The laws of nature may change; the supposition of such a change would involve no such absurdity as that which would be implied in the supposition that the three angles of a triangle could ever exceed or fall short of two right angles. This truth would remain undisturbed, however the properties of matter might be modified, and even though matter were to be altogether annihilated. It is obvious, that we reckon upon the continuance of the properties of matter, and the return of natural phenomena, only to the extent to which we reckon upon the permanence of the existing natural laws. And Laplace has calculated the probability that the sun will not rise to-morrow. But, assuming the unchangeableness of Nature's laws, we are authorized in regarding certain of its phenomena as unalterable truths. For instance, if the planet we inhabit is clearly ascertained now to be a round body, we conclude that it will remain round as long as it lasts. If it is as clearly seen to rotate, we conclude in like manner that it will always rotate; its rotation ceases then to be an hypothesis — it becomes an observed fact, the evidence for the truth of which is not increased by the confirmations of future experience, nor by its satisfactorily accounting for whatever phenomena may be referred to such rotation. It is a matter of some importance, therefore, that the rotation of the earth is taken out of the category of hypotheses, and classed among observed physical truths, as we now proceed to show.

* Physical Astronomy, in the *Encyclopædia Metropolitana*, by Sir J. F. W. Herschel, p. 648.

Faucault's Pendulum Experiment.—Let the reader conceive before him a circular table, upon which, passing through its centre, the meridian line is drawn. If the earth have no rotation about an axis, this line can never change its direction; if it do rotate, the direction must continually vary, except the place of observation be at the equator. This will readily appear from the following considerations.

Let our horizontal meridian line be indefinitely extended; we shall thus have an indefinite straight line in the plane of the terrestrial meridian and touching the surface of the earth, the point of contact being the centre of the table; we may, of course, regard the table-top as lying horizontally on the ground.

For any place of observation between the equator and the pole, it is obvious that if the earth turn round its axis, this tangent line will, in one complete rotation, describe a conical surface enveloping the globe; and as the vertex of the cone is necessarily at a finite distance, the line which generates its surface—thus always pointing to a fixed determinate point (the vertex)—must continually change its direction, which however it cannot do if the earth be at rest.

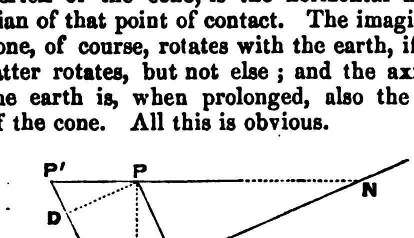
But if the place of observation be at the equator, what, in the case just considered, is a conical surface, would evidently be a cylindrical surface; the straight line generating it would then always be parallel to itself, and therefore, though the earth should really rotate, there would be no more change of direction in the meridian line than if it were at rest.

If, however, the centre of the table were directly over the pole, then, taking any diameter of the table for a meridian line, the changes in its direction, if the earth rotate, would clearly be more rapid and more considerable; it would pass through a revolution of 360° for every complete rotation, and the surface described by the line would be a plane surface.

It is thus easy to see what must necessarily

happen, as to the direction of the horizontal meridian, if the earth has any rotation about its axis. At the equator, the direction would remain undisturbed, and the line would generate a cylindrical surface; at a small distance from the equator, the cylinder would become a cone, and the direction of the line would regularly, but only slightly, change; at a greater distance from the equator, the cone would differ more palpably from the cylinder, and the angular deviation of the line—(always directed to the vertex of the cone)—would be more considerable. As the place of observation approaches the pole, the cone would, as it were, widen out more, the deviation of the line would become greater and greater, in a given time, till at length, when the pole is reached, the cone would spread into a plane, and the change of direction would be the greatest possible.

The reader will find it of much assistance, towards clearly apprehending what is to follow, if he keep constantly before his mind this idea of the enveloping cones. Every parallel of latitude is to be regarded as the circle of contact of a cone, the apex of which becomes less and less remote as the parallel approaches the pole. We shall call the cone adapted to any particular parallel the cone of latitude of that parallel—a designation which is sufficiently significant. The extreme cases of the cone of latitude are the cylinder and the plane: the former belongs to the equator, the latter to the pole; the angle of the former is 0, that of the latter 180°. The straight line from a point of contact to the vertex of the cone, is the horizontal meridian of that point of contact. The imaginary cone, of course, rotates with the earth, if the latter rotates, but not else; and the axis of the earth is, when prolonged, also the axis of the cone. All this is obvious.



Let now P be the centre of the circular top of the table, P P' half its meridional diameter, N S the axis of the earth, prolonged to meet the vertex of the cone of latitude in N. The angle N will be equal to the latitude of the point of contact, P; because if a line P C be drawn from P to the centre of the earth, the angle P C N will evidently be the complement of the latitude, consequently since N P C is a right angle, the angle N is the latitude.

Over the point P, let now the bob of a pendulum freely hang—the longer the wire or cord by which it is suspended the better; but it must be so attached to the support above as to be equally free to vibrate in any direction. Let the pendulum be made to vibrate in the direction of the meridian line N P; and, if the earth rotates, let us try to anticipate the phenomena that will be presented to us.

The point P, immediately under the bob when at rest, must rotate slower than the points in the meridian line more remote from the apex of the cone; so that as the bob sweeps over those points, they must keep proceeding in advance of it, that is, towards the east if P be in north latitude, as here supposed. The rate of rotation of the bob round the cone must be the same whether it oscillate or not, because the fact of its oscillating cannot interfere with any motion of revolution round the cone it may have had when hanging freely. We see, therefore, that the path of the pendulum, that is, its line of vibration, must appear to be gradually receding from the meridian line P' P towards the west, making with P' P an angle of deviation which increases at every oscillation.

Actual experiment fully justifies these anticipations—the deviation of the track of the bob is seen to be in complete accordance with them; and although, in the following mathematical investigation of the exact amount of deviation in a given latitude and in a given time, allowance must be made for mechanical imperfections and for the accidental impulse to the right or left communicated to the bob by the hand in giving the initial impulse, and which will give rise to what is called an apsidal motion, yet with only very ordinary care the natural tendency of the pendulum sufficiently overrules those hindrances to render the deviation of its path towards the west always palpable, and always accumulative.*

The rotation of the earth from west to east is the only way of accounting for this apparent deviation of the path of the bob. What

* In the experiment as performed at the Royal Institution of Great Britain, the impulse was not given by the hand; the bob was drawn out of the vertical line by a silken thread, the end of which was fastened to a peg in the floor; a flame was then applied to the thread, and the ball set free. The author of this treatise first witnessed the experiment at the house of a scientific friend, W. H. Spiller, Esq., of Highgate; in the different repetitions of it, the suspending wire, nearly twenty feet long, was of different metal, and the hand was employed to let the bob go. The deviation was quite palpable in eight minutes. —Nautical Astronomy, *Orr's "Circle of the Sciences,"* p. 81.

extraordinary portion of it appears to me to be the difficulty of cutting up and dividing the rate into such exceedingly small homœopathic proportions as 54 hundredth parts of a second. I may merely remark, the temperature these chronometers were tried in rarely changed more than 20 degrees in any one month during the trial, and they were not tried at all in extremes of high and low temperature. If they had been so tried, the balance would have shown precisely the same error as it now does.

The timing of the dozen chronometers mentioned by Mr. C. Frodsham suited most admirably for a temperate and southern climate; but, suppose in the following winter these chronometers are in a northern expedition, in a few weeks their errors would have been enormous, as the most impartial reader will perceive the whole error of the balance was designedly placed to the account of the cold.

I cannot close this letter without making some reference to the balance invented by Mr. Hartnup, of the Liverpool Observatory, of which a description has been given in your Journal. Mr. Hartnup, in his work in which the balance is more fully described, gives two Tables, showing how a chronometer, "William Shepherd, No. 222," performed with the ordinary construction of balance, and again how the same chronometer performed with the new balance invented by him and made by William Shepherd. I extract the same, which may be read with interest by those who may not have perused his pamphlet:—

TABLE No. 2.
Ordinary Balance,
William Shepherd, 222,
In order of daily gain.

Sec.	Temp.
— 9·0	34·5
— 5·8	42
— 3·7	50·5
— 1·0	65
— 0·7	73
— 1·7	83·5
— 2·4	92
— 4·1	105
— 5·6	107
— 5·8	110

TABLE No. 3.
Improved Balance,
William Shepherd, 222,
In order of daily gain.

Sec.	Temp.
— 2·5	28·5
— 2·4	32·5
— 3·2	32·5
— 2·9	37·0
— 2·9	33·5
— 3·2	51·5
— 3·4	53·0
— 2·4	71·0
— 3·6	88·0
— 2·0	88·5
— 1·9	99·0

Three chronometers with this new balance were deposited at the Royal Observatory on trial for purchase in the year 1848. Two of them did not perform so well there as they did at Liverpool. One of them was purchased by the Government. Many other chronometers with the new balance have been tested at Greenwich since 1848, and nearly all of them have performed well.

I think these facts will be well worthy the attention of any one contemplating a new compensation balance. With regard to the balance spoken of by Mr. Cole, it is impossible to state what its merits may be until the same tests have been applied, which will soon tell the plain unvarnished tale.

Trusting you will excuse my trespassing on your pages, I am, Sir, your obedient servant,

ONUS PROBANDI.

Biographical Memoir of

CHARLES STEPHEN LOUIS CAMUS.

This eminent mathematician and mechanician was born at Cressy en Brie, near Meaux, the 25th of August, 1699, being the son of Stephen Camus, a surgeon of that town and Margaret Maillard. His taste for practical mechanics was very early demonstrated by a singular ingenuity in the construction of a variety of little machines with which he amused himself; and he soon felt so strongly the value of mathematical studies, that he urged his parents to find the means of sending him to a school where he might apply himself to them. In compliance with his wishes he was placed, when little more than ten years old, at the College de Navarre, in Paris; and in two years he acquired knowledge enough to become an instructor of others, and to relieve his friends from all further expense in his education. He was assisted in the pursuits of the higher departments of the mathematics by the celebrated M. Varignon, and he particularly applied himself to civil and military architecture and to astronomy.

The first result of his studies that was destined for the public eye was an Essay on the Masts of Ships; a subject which had been proposed, in 1727, as a prize question by the Academy of Sciences. This essay was received with considerable approbation, and was inserted in the second volume of the Collection of Prize Memoirs. Shortly after the author was made an adjunct or subassociate of the Academy, in the department of mechanics.

In 1728 he brought forward a memoir on the living force of bodies in motion; in which he concludes, from considering the actions of springs and other similar powers, that its true measure is the product of the mass into the square of the velocity, as Leibnitz maintained; this product being also proportioned to that of the force into the space through which it acts, while the momentum

is proportional to the force and the time conjointly.

In December, 1730, M. Camus was appointed Professor of Geometry to the Academy of Architecture; and a few years afterwards he became secretary to the same body.

The Memoirs of the Academy for 1732 contain a short paper on a problem proposed by Mr. Cramer respecting the determination of two curves bearing a particular relation to each other. It was the custom of the age to consider exercises of this sort as trials of strength to which it was incumbent on all geometricians to submit, for the honour of the countries in which they lived and of the societies to which they belonged.

The author was elevated in 1733 to the rank of an associate of the Academy, together with Clairault, over whom he even obtained some advantage in the ballot. He communicated to the Academy in the same year a valuable paper on the teeth of wheels. La Hire had already laid the foundation of the investigation on its true basis, and had pointed out the use of different epicycloidal curves for the forms of the teeth of wheels in different circumstances, and M. Camus in this essay enters into some further inquiries, particularly with regard to the best proportions for the length of the teeth and the comparative diameters of the wheels; a discussion for which his intimate acquaintance with the art of the clockmaker made him particularly well qualified.

In 1736 he accompanied Maupertuis and Clairault in the expedition to Lapland for the measurement of a degree of the meridian, and he was enabled to render them very essential service, not only as a geometrician and an astronomer, but also by his skill in various departments of the mechanical arts, which became particularly valuable in so remote a situation.

M. Camus directed his attention, in 1738, to the well-known but interesting mechanical phenomenon of a pistol ball piercing an open door without causing any very sensible motion in the door, and published a paper on the subject in the Memoirs of the Academy. He justly observes, that the effects of any force depends not only on its magnitude, but also on the time for which it operates; and that though the impulse of the ball must tend to carry the door before it with a force paramount to the resistance which it opposes to the ball, yet the time of the action of this force is too short to produce a sensible effect on the whole mass of the door.

In 1739 he presented to the Academy two hydraulic memoirs—the one on water buckets, the other on pumps. In the latter he investigated the diameter of a valve capable of transmitting the greatest quantity of water within a given barrel,—a valve which is too large not being at liberty to rise to a sufficient height.

He inserted in the Memoirs for 1740 a computation of a mechanical fallacy which has misled many of the enthusiasts who have bewildered themselves in the search of a perpetual motion, demonstrating that when a number of weights are caused to descend in any imaginable paths at a greater distance from the centre of a wheel than they ascend, the number of the weights descending at one time must always be smaller than those of the weights ascending, and in such a proportion as perfectly to compensate for the mechanical advantage apparently gained by the greater distance.

In the following year he was received into the number of academicians in the department of Geometry, on occasion of the resignation of M. Fontenelle.

He published also in the Memoirs for 1741 an account of a gauging rule for measuring barrels of different forms by simple inspection of a logarithmic scale engraved on it, observing only some easy rules for their adjustment according to the general nature of the solid.

In 1746 he presented a report, in conjunction with M. Hellot, on the length of the standard ell, which was thought worthy of being inserted in the Collection of the Academy.

We find among the Memoirs for 1747 an essay of M. Camus on the tangents of curves having several branches crossing each other, which frequently require for their determination the use of fluxions of the higher orders, the first fluxions of the absciss and ordinate vanishing together. M. Saurin had before given a similar solution of the problem, but had not attempted to explain the metaphysical ground upon which the apparent paradox is reconciled to the general principles of the differential method.

M. Camus also assisted in several determinations and reports which were referred at various times to committees of the Academy, and particularly on the measurement of M. Picard's base from Villijuif to Jewisy, which was performed by eight members and recorded in the Memoirs for 1754.

The latter years of his life were much occupied in various engagements connected with the offices of Examiner in the schools of the Royal Engineers, and in that of the Artillery, to which he was nominated by the King. He undertook, for the advantage of the students in these schools, the laborious

task of reducing into a uniform system a complete course of mathematical study, in which the geometrical method was as much as possible observed, and which is considered as highly creditable to his talents and exertions. It was entitled "Cours de Mathematiques," 4 vols. 8vo. He also published an elementary work on arithmetic.

In person M. Camus was tall; his countenance was agreeable; his manners were firm, and occasionally somewhat warm, but he was far from being either morose or vindictive. He was elected a foreign member of the Royal Society of London, in January, 1764. He married, in 1733, Mademoiselle M. A. M. Fourrier, and had four daughters; the eldest of whom was married to M. Pagin, the others died young.

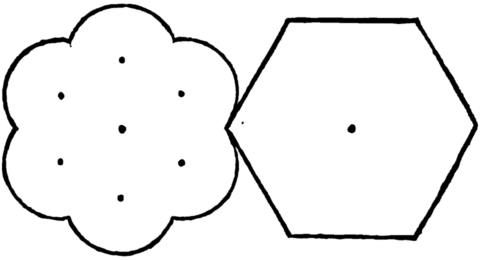
His last illness was supposed to have originated from a cold taken in a professional journey during the hard winter of 1766, and to have been aggravated by affliction for the loss of his last surviving daughter. He died a few months after her, on the 4th of May, 1768. He left a variety of manuscripts, demonstrative of his habitual diligence and of the extent of his researches, but not deemed of sufficient importance to meet the hazards of posthumous publication.—*Hist. Acad.*, Paris, 1768.

ADAPTATION OF WHEELS AND PINIONS.

To the Editor of the Horological Journal.

Sir,—It is found by experience that the teeth of wheels and the leaves of pinions are frequently much cut by friction at the points of contact. This frequently arises from the effect of bad pitchings, but more frequently from the fact that the teeth of the wheel and the pinion leaves are not adapted to each other in form, and consequently a rubbing instead of a rolling motion is produced.

It matters not of what form the wheel tooth may be, so that the pinion leaf is adapted to it. It is well known that there is a line where any formed tooth would roll on a properly formed pinion leaf without rubbing. Hence I considered that a full round tooth to pitch in with a rounded pinion leaf is one extreme of bad form. This *practical* mode of reasoning may be carried on from these forms to a full round tooth with a *linear* pinion leaf, and thence to the form which I herewith inclose as being the other extreme. And if a good form is wanted, we must seek it between the two extremes, where they shall roll on each other without rubbing. Now if you firmly secure *pivoted* arbors in each of the inclosed wheels, and pitch them nicely into each other, you will find that either of them will drive the other.



I do not recommend this form of wheels for practical use; it is merely the one extreme of a deviation from the best form. And the other extreme, namely, a full bosom tooth, and pinions *the same*, are both decidedly wrong. I think I need not go further into a discussion upon this point, as amongst practical men these remarks are easily understood.

If you think these remarks worthy a place in the journal, they are, together with the models, at your service.

I am, Sir, your's respectfully,

S. LONG.

Kingston-on-Thames.

☞ In consequence of the great pressure of matter this month, we are reluctantly compelled to omit the EQUATION TABLE in the present number; as also the Abridged Specifications of Patents, both of which will be resumed in our next issue.

TO CORRESPONDENTS, &c.

All Communications for this Journal should be addressed to the EDITOR, *at the Office*, 35, Northampton Square, Clerkenwell.

N. B. Advertisements to be inserted in the Journal must be received before the 25th of the month.

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ELEMENTARY PAPERS

ON MECHANICS AND MATTER IN MOTION.

(*Continued from page* 13.)

FAUCAULT'S PENDULUM EXPERIMENT—*continued.*

Time in which the Meridian line completes a Revolution.—As the absolute direction of the oscillations remains invariable, it follows that when the cone of latitude has turned through any angle, the original horizontal line must have turned through an equal angle; so that when the cone has made a complete revolution, the deviation of the path of the bob from the horizontal line amounts to an angle equal to the plane angle given by developing the conical angle.* This, it is obvious, can never amount to so much as 360°, or a complete revolution of the table, except when the bob is suspended over one of the poles of the earth, the conic surface then becoming a plane tangential to the sphere at the pole. Proceeding from this extreme limit towards the equator, the angle of the cone becomes less and less, till on reaching the equator it vanishes altogether, as before remarked,—the cone then becomes a cylinder, and no deviation can take place.

It thus appears that the angle of deviation in any time, at any place, is a plane angle exactly equal to the development of the corresponding conical angle turned through in that time by the rotation of the cone of latitude. It remains to be ascertained what part this angle of deviation is of a complete revolution, or 360°. In other words, we have to ascertain what part of 360° the developed angle of the apex of the cone of latitude amounts to.

Conceive an upright cone, unconnected with the globe, and from its apex let any two straight lines be drawn along the slant side, intercepting an arc of the base. This arc will measure a certain angle at the centre of the base. Measure from the apex along either of the two lines drawn from it a length equal to the radius of the base, and describe, with this length as radius, a circular arc limited by the two straight lines on the cone. This arc will evidently measure the conic angle, it will therefore be to the corresponding arc of the base as the angle at the apex to the corresponding angle at the centre of the base; but the developed arcs are also to one another as their distances from the apex, for these distances are their radii. Hence the conic angle is to the corresponding plane angle (or angle of deviation on the horizontal plane) as the radius of the base of the cone to the length of the slant side; that is, as the sine of half the plane angle of the cone to unity. Consequently the whole conic angle is to 360° as the sine of half the plane angle of the cone—that is, as the sine of the latitude is to unity. Hence, from what is shown above, the angle of deviation (x) of the path of the bob in one entire revolution of the earth is to 360° as the sine of the latitude is to unity. The time of this revolution is 24 hours; consequently 24 hours divided by the sine of the latitude is the time in which the path of the pendulum makes a complete revolution in that latitude. Thus, assuming the deviation to be 360°, we have

$$360^\circ = x \text{ sin. lat.} \therefore x = \frac{360^\circ}{\text{sin. lat.}} \text{ in } \textit{degrees}$$

$$\therefore x = \frac{24 \text{ hours}}{\text{sin. lat.}} \text{ in } \textit{time}.$$

And all the more carefully conducted experiments justify this result, within those limits of difference that may reasonably be attributed to the disturbing causes adverted to above.

We have further obtained, from a few simple considerations, the following interesting proposition—namely,

The length of the arc of the rim of the table subtending the angle of deviation at its centre, which a pendulum oscillating over it makes during one rotation of the earth, is exactly equal to the difference between the parallel of latitude described by that centre and the parallel described by the extremity P′ of the meridional diameter of the table.

Draw P c, P′c, perpendiculars upon the axis of the earth (see last diagram), and P D parallel to the axis N S. It has been proved above that the angle of deviation in one revolution of the earth is

$$360^\circ \text{ sin. N} = 360 \frac{P'c'}{P'N} = 360 \frac{P'D}{P'P}$$

This angle, multiplied by the radius P P′ of the table, and by 3·1416, and the product divided by 180°, is the arc of the rim of the table subtending it; that is, the measure of this arc is 2 P′ D × 3·1416. But twice P′ D is the difference between the diameter of the two parallels described by P and P′.

* The proper distinction must, of course, be observed by the reader between the "angle of the cone" and the "conical angle." The angle of the cone is the plane angle of the isosceles triangle which the section of the cone through its axis presents; the conical angle is the angle at the vertex, formed by the surface of the cone. If this surface be cut along the straight line which may be conceived to generate it, and then the surface developed or unfolded into a plane, the conical angle will become an equivalent plane angle.

Hence the arc that measures the angle of deviation in one revolution of the earth is equal to the difference between the two circumferences described by P and P′. And the arc of deviation due to any portion of a complete revolution of the earth is equal to the difference between the two portions of parallels described by P′ and P′.

The same conclusion may be obtained by aid of considerations still more simple. It is plain that the difference between the circumferences of any two equidistant circles on the surface of a cone is always the same; hence, if a circle be described about the apex, with a radius equal to P P, the circumference of it will be equal to the difference between the two circumferences described by P and P′. But this same circumference, when the cone is developed, is the arc of deviation, on the table, due to a complete revolution of the earth; hence this arc must be equal to the difference between the two parallels described by P and P′ in a complete revolution.

It thus appears, not only that the pendulum experiment affords ocular demonstration of the rotation of the earth, but that it moreover exhibits to us the actual velocity, in linear measure, with which the point P′ proceeds in advance of P. It is the velocity with which the arc of deviation increases.

If the length of this arc described in any interval of time be measured, we may readily deduce the arc that would be described in a complete revolution of the earth. If the length of this arc be taken for the circumference of an entire circle, the diameter of that circle may be inferred. This diameter applied as a chord to the circle of deviation will subtend an arc of it, the degrees and minutes of which will be double the latitude of the place. And thus we may conceive it possible, that a person conveyed to a dungeon in some unknown part of the world, with a piece of string and a weight at hand, might form an estimate of the latitude of his position.

Application to an Unexplained Phenomenon in Falling Bodies.—The idea of the cone of latitude will subserve the purpose of accounting for a circumstance in the late M. Oersted's experiments on falling bodies hitherto, we believe, involved in some obscurity. The following experiment is from the *Literary Gazette*, of March 22, 1851 :—

"One of the most important observations, first made by Oersted, and since then confirmed by others, was, that a body falling from a height not only fell a little to the east of the true perpendicular (which is, no doubt, due to the earth's motion), but that it fell to the south of that line: the cause of this is at present unexplained. It is, no doubt, connected with some great phenomenon of gravitation which yet remains to be discovered."

The explanation of this phenomenon is very easy. Suppose a heavy body to be let fall from a point at a considerable height vertically over P. When it is let go, the body will have a progressive velocity towards the east greater than the velocity of P at the foot of the vertical; and this velocity it will preserve throughout its descent, which, from the nature of gravity, must be in a vertical plane through P C, C being the centre of the earth. Now the point P, at the foot of the vertical line, recedes from this plane, towards the north, during the descent of the body; it always keeps in the plane through P *c*, and perpendicular to the axis of the earth, and describes a circle whose radius is *c* P on the cone of latitude. The body, therefore, must necessarily fall towards the south of P, as well as towards the east. If the experiment be made in south latitude, the deviation will, of course, be north instead of south.

It is plain that in Oersted's experiment the falling body, by the rotation of the earth, and therefore by its own more rapid easterly motion, had advanced more towards the east when it reached the ground than the point P at the foot of the vertical, but it had not advanced at all towards the south; it was the foot of the vertical (the point P) that had receded towards the north.

These experiments prove in the most satisfactory manner that the earth really rotates on its axis. We are made sensible of this rotation in other ways also. "It is well known to engineers, that when railway carriages are going north, their tendency is to run off the rails on the east side, but when the train is going south, their tendency is to run off on the west side of the track—that is, always on the right hand." * In the former case the train at starting is moving eastward with a velocity greater than that with which any more northerly point of the track moves; and in the latter case, it is moving more slowly towards the east than any more southerly point of the track, and hence the uniform tendency to escape the confinement of the rails towards the right.

* Maury's "Physical Geography of the Sea," page 39.

(*To be continued.*)

FURTHER REMARKS ON

CHRONOMETER, WATCH, AND CLOCK-MAKING.

By Mr. Charles Frodsham.

To the Editor of the Horological Journal.

Sir,—I fear that my remarks upon the momentum of the balance at page 157, may lead to some misconception of the subject. The momentum, or work which I have prescribed for every balance to do, according to the nature and power of the watch, is based upon a certain fixed extent of arc of vibration, viz.: pocket chronometers, $1\frac{1}{3}$ turns, or 240 degrees on each side of the quiescent point; duplex, $1\frac{1}{10}$; levers, $1\frac{1}{4}$; and half-seconds marine chronometers, $1\frac{1}{4}$. For which latter a special Table has been calculated, as that extent of vibration would not be suitable to the other trains without an altered balance spring; whilst, with this exception, in all the other series of trains the balance spring must be either the same identical spring, or one perfectly similar thereto in strength; so that the balance spring may be considered as equivalent to, or to have a determinate relation to the mainspring; or, in other words, a certain strength of balance spring is in accordance with a certain amount of momentum, whatever train, diameter and weight of balance may be employed, to suit the judgment of the workman, mean time being left to settle the rest.

The momentum of the balance is represented by the weight in grains multiplied by the square of the velocity; and, in order that the resulting number which expresses it may not come out inconveniently large, the diameter is best taken in decimal parts of an inch, the time with reference to the second, and the arc of vibration with reference to the entire circle of 360 degrees. For instance, if a pocket chronometer make 18,000 vibrations per hour, 300 per minute, or 5 beats in every two seconds,* carry a balance of 1 inch diameter and 25 grains weight through an arc of vibration equal to $1\frac{1}{3}$ parts of a circle, its momentum will be represented by the number 7·1111 &c.; for the velocity is $\overset{\text{diam.}}{1} \times \overset{\text{sec.}}{\frac{2}{5}} \times \overset{\text{circle.}}{\frac{4}{3}} = \frac{8}{15}$ and the velocity $\frac{8}{15}$ squared multiplied by 25 grains weight $= \frac{8}{15} \times \frac{8}{15} \times 25 = \frac{64}{9}$ or 7·1111 &c. But if we wish to increase the weight, say, to $44\frac{1}{4}$ grains, keeping the same diameter, we must employ a stronger balance spring if we desire the same extent of vibration, or, retaining the same balance spring, the increased load will necessarily be carried a shorter distance by the same power, and the arc of vibration, which was originally 480 degrees, will be now reduced to 360; still the same power will be doing the same amount of work, only the weight and velocity will be differently apportioned among themselves. If, however, this liberty were allowed, my Tables would cease to be a rule and a guide; for experience has satisfactorily determined that each balance must have a certain arc of vibration, or no good result can be permanently maintained; and my experience has convinced me, that when the work has been well executed, the vibrations of the balance should alter very little, even after two years going.

It is very remarkable to observe, how much all defects increase in effect as the oil begins to thicken, or when the escapement has been left with too much drop, or the wheels and pinions are of a bad shape &c., &c.—defects which soon make themselves known and felt. A bad shape in the great wheel teeth is more detrimental than in the pinion, and as much as ten per cent of the power may be wasted from this cause.

No subject has received greater attention in the earlier mechanical ages than the forms required for the teeth of wheels and pinions. I have examined the teeth of some of the old mill-wrights' wheels with boxwood cogs, which, after years of action, have not shown the slightest wear and still continued to gear with a smooth rolling contact.

A good watch should never have a pinion of less than 12, that being the lowest number that commences to drive behind the line of centres. See Moinet's work on Watchmaking; see also Professor Willis on the Principles of Mechanism; but a visit to King's College, where the inquirer after knowledge is always most courteously received, will afford a very valuable lesson upon this interesting subject. After considerable trouble, I succeeded in getting some of the Lancashire wheel-cutters to carry out the highest theory of wheel-cutting; but, unless you are constantly urging upon them its importance, and are narrowly looking after them, from the difficulty of making cutters of the proper shape, and the extra care required in using them, they soon fall into the old habit of cutting the teeth in the shape of a pear instead of that of a willow leaf, which is a very close approximation to general truth and requirement. It is very remarkable to observe how this and other popular fallacies are perpetuated and handed down from one to another almost without enquiry; and how often an able workman allows himself to be tripped up by a pebble from the want of a little reflection.

* There are 10 vibrations in two seconds, but only 5 beats, the other 5 being silent.

The great wheel is the first transfer of power from the barrel, and as every defect in the gearing becomes much aggravated by the time it has reached the escapement, I make it a rule to have the acting part of the tooth of the most perfect shape, and the spaces with a hollow circular bottom, which gives to the base of the tooth a pyramidical form, and contributes to its strength as well as to its proper shape.

I have often been told by some persons that power is obtained by large wheels, and by others, that it is got by small wheels. These are popular fallacies, for there are no means of creating power except by a larger barrel and consequently a stronger mainspring; but there are many ways of wasting it, such as by badly shaped teeth and pinions, too much drop, more especially in the escapement. Small wheels are useful for packing the wheel-work, and more necessary in three-quarter plate watches than in those with whole plates, and on the other hand large wheels admit of a greater number of teeth; but, whether large or small the power is the same so long as the wheel and its pinion bear the same relative proportion to each other.

I used to attach undue importance to the weight of the wheel-work; but, upon examination, I found the same work done in a large carriage clock wherein the wheels are clumsy and heavy, as in the fair average of chronometers and watches, which carry the exact proportion of balance as to weight and diameter due to their respective barrels.

CHARLES FRODSHAM.

84, Strand, London,
15th September, 1860.

REMARKS ON MR. FRODSHAM'S PAPERS.

To the Editor of the Horological Journal.

Sir,—I have read with interest the papers by Mr. Frodsham which appeared in the July and August numbers. Anything coming from so high an authority cannot but be welcomed by those engaged in the manufacture of chronometers, and read with profit by those who, as a matter of pleasure or business, take a scientific interest in the subjects of horology. Having had some experience in rating as well as in using chronometers, I beg to offer a few remarks.

Mr. Frodsham states that the mean temperature of the navigable ocean ranges from 50 to 80 degrees. This, to say the least, is misleading. It is well known that on voyages to Australia, round Cape Horn, or even to the northern ports of the United States and those of British America, to say nothing of the Baltic and White Seas, to whaling and sealing localities, temperatures are frequently experienced as low as 40°, and even the freezing point is not uncommon, both in the water and the air. No doubt the temperature of the cabin, in which the chronometer is placed, is seldom so low as that of the external air; but in some localities and ports the temperature in the cabin is often 100° or more. Hence, though the chronometer *may* escape the extreme cold by taking care to keep up the temperature artificially, by means of a fire day and night, no precaution can prevent it being affected by extreme heat. There can be no dispute that chronometers intended for long voyages, during which nearly all vicissitudes of climate may be experienced, should, if possible, maintain a constant rate in all temperatures between 40° and 100°. Ships making polar voyages, and those constantly engaged in tropical regions, should carry chronometers which have been compensated specially for low or high temperatures, as the case may require.

Those who have had the opportunity of testing the performance of chronometers in temperatures varying from 40° to 100° know perfectly well that they never have the same rate of gain or loss throughout that range, not even those which are fitted with auxiliary compensation balances. With the ordinary compensation balance the change of rate for change of temperature I believe to be somewhat like this:—Suppose the instrument to keep mean time in 60°, in 40° and 80° it will lose from one to two seconds daily, although the compensation be as well effected as possible. If it has been indifferently adjusted and compensated, it will lose much more. Or, to state the case in a different manner, if the chronometer were "timed" for two temperatures, as 50° and 70°, it would gain on its rate in the intermediate temperatures, and lose in the extreme temperatures. Mr. Frodsham instances the performance of several chronometers which went to Jamaica. These, I conclude, were "timed" for about 55° and 80°, and in 34° lost on their rates 2ˢ.7, and in 68° gained only 0ˢ.4. I should have expected the change to have been greater.

Although the ordinary compensation balance is thus defective, I do not know of any improvement on it which I should consider safe, were I in charge of a ship;—and "I would never trust myself to sea with any of them." The fact is, no auxiliary compensation balance has been invented, which is sufficiently stable in construction and scien-

Fig. 3.

other plank, not less than half an inch in thickness, and let it be sawn or otherwise exactly shaped to those curves, see *figs.* 4

Fig. 4.

Fig. 5.

and 5; the first of which, being of the same curvature with the pitch line of the pinion C D, and the second, the same sweep as that of the wheel A B, a hole must then be bored obliquely in each, commencing a quarter of an inch from the edge on one side, and terminating on the opposite side; into each of which holes a nail, &c. must be driven until the points project a little below the holes, as at E E. These points must then be filed, so as to leave them exactly in the peripheries of the circles, just long enough to make an impression upon any plane surface placed beneath them, and must be rounded and made conical, so as to trace a smooth even line. Then, after having rubbed the side or circular edges of the segments with powdered resin, fix the segment (*fig.* 4) fast upon the pitch line of the pinion; and apply the tracing point in the other segment (*fig.* 5) successively to all the divisions of the teeth in the said pitch line, and, pressing its edge close to the edge of the fixed segment, cause it to roll or revolve about it, without slipping one way or the other, until it shall have described the curves proper for all the teeth of the pinion. Then, taking off the small segment from the pinion, fasten the larger one upon the pitch line of the wheel, and proceed to describe the curves of the teeth of the wheel with the tracing point in the small segment, exactly in the same manner as those of the pinion.

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

(*Continued from page* 140, *vol.* ii.)

1837, November 2.—No. 7456.

GOWLAND, James.—1. The communication of motion or impulses to the balance directly through the medium of the balance spring, whether according to any of the modifications shown in the Specification, or by an alternating lever, or in any fit and proper manner.

2. A revolving escapement bar, and a locking rim. [Printed, 1*s.* 1*d.*]

1838, June 9.—No. 7678.

MASSEY, Edward John.—The patentee describes his claim as :—"Two detents upon separate axles, "which give me the advantage of using very delicate "springs, and of locking the pallet wheel very near to "the centre of a circular detent, and of unlocking it "without passing the verge farther than is requisite "in other chronometer escapements, so that the balance "is less opposed in raising the locking, and in its "return after receiving the impulse, by which means "the same mean power is enabled to carry a much "heavier balance."

[Printed, 5*d.* See Repertory of Arts, vol. 11 (*new series*), p. 93.]

1838, September 13.—No. 7807.

MASSEY, Edward.—1. A new verge for the common balance-wheel watch. Notches are cut to receive the pallets, which are made of ruby or other stone sufficiently hard, and are cemented in the notches.

2. A detached marine chronometer escapement, having, instead of straight springs, springs made in the same manner as common pendulum springs.

3. Watch escapement to drop seconds. The wheel, made similar to a duplex wheel, has two pallets acting on it. The leading pallet acts as a locking pallet only on the external tooth of the wheel, and when this is unlocked the wheel falls on the receiving pallet, and on the return of the balance it communicates the whole or nearly the whole of the impulse in one vibration instead of two.

4. The application of an endless chain and pulleys to clocks made with fusee or barrel, so that the key, in order to wind up the instrument, is applied in the stand of the watch, being particularly adapted to clocks with glass shades over them.

[Printed, 3*d.*]

1838, November 15.—No. 7874.

MACDOWALL, Joseph Eden.—The object of the invention is to reduce the number of impulses by which the escapement axis is caused to make a revolution; the number being reduced to three, two, or even one. On the cylinder on the balance axis is an inclined plane; on the axis on which the locking piece is fixed is a screw with a projecting flange, and when the locking piece is unlocked this flange rolls down the inclined plane. The number of degrees of impulse will depend upon the quantity of space which the inclined plane extends over on the cylinder.

[Printed, 1*s.* 1*d.* See London Journal (*Newton's*), vol. 14 (*conjoined series*), p. 361.]

1839, June 27.—No. 8134.

NEWTON, William.—Improvements in the construction of sun dials, consisting of certain machinery, on which the plate and gnomon of a sun dial is to be mounted for the purpose of adjusting the position of the dial plate according to the varying difference between solar time and mean time. The dial plate is placed on a moveable saddle or easel, and on the fixed frame of the apparatus is a toothed wheel, with a graduated circle on its face divided into 365 parts to represent the days of the year. On the plate of the toothed wheel is an excentric plate, the edge of which is curved in such a manner that, with respect to each division of the circle of days brought under an index or pointer, the said curve presents for every day a projection or difference of radius corresponding exactly with the difference between the solar and mean time. A bent arm connects this with the saddle or easel, and forms a lever by which the dial is with the saddle or easel occasionally moved in a vibratory direction, so as to be placed at different inclinations to the horizontal plate.

[Printed, 7*d.* See London Journal (*Newton's*), vol. 16 (*conjoined series*), p. 352; and Inventors' Advocate, vol. 2. p. 36.]

1839, July 6.—No. 8145.

PHILCOX, George.—"The patent diamond lever "escapement." The detent or balance lever, which receives its impulse from the impelling lever, is called by the inventor, from its peculiar form, "the diamond lever;" the part worked upon consisting of two sides at a slight angle to each other, so that there are three points of contact between the two levers.

[Printed, 5*d.* See Repertory of Arts, vol. 17 (*new series*), p. 21; London Journal (*Newton's*), vol. 16 (*conjoined series*), p. 325; and Inventors' Advocate, vol. 2. p. 135.]

(*To be continued.*)

EQUATION OF TIME TABLE

For October 1860.

Day of the Week	Day of Mnth	At Apparent Noon — Equation of Time to be *subtracted* from Apparent Time		Difference [illegible] One Hour.	At Mean Noon — Equation of Time to be *added* to Mean Time.	
		m.	s.	s.	m.	s.
Mon...	1	10	27·66	0·787	10	27·80
Tues..	2	10	46·54	0·773	10	46·68
Wed ..	3	11	5·09	0·759	11	5·23
Thurs.	4	11	23·30	0·743	11	28·45
Fri....	5	11	41·14	0·726	11	41·28
Sat. ..	[illegible]	11	58·57	0·709	11	58·71
Sun...	7	12	15·60	0·691	12	15·74
Mon...	8	12	32·18	0·673	12	32·32
Tues..	9	12	48·30	0·653	12	48·44
Wed ..	10	13	3·96	0·632	13	4·10
Thurs.	11	13	19·11	0·611	13	19·25
Fri. ..	12	13	33·77	0·589	13	33·90
Sat. ..	13	13	47·90	0·566	13	48·03
Sun...	14	14	1·48	0·543	14	1·61
Mon...	15	14	14·52	0·520	14	14·64
Tues..	16	14	26·99	0·495	14	27·11
Wed ..	17	14	38·88	0·470	14	39·00
Thurs.	18	14	50·17	0·445	14	50·28
Fri ...	19	15	0·86	0·419	15	0·96
Sat ...	20	15	10·92	0·392	15	11·02
Sun...	[illegible]	15	20·35	0·365	15	20·44
Mon...	22	15	29·12	0·338	15	29·20
Tues..	23	15	37·24	0·310	15	37·32
Wed ..	24	15	44·67	0·281	15	44·74
Thurs.	25	15	51·41	0·251	15	51·48
Fri. ..	26	15	57·43	0·221	15	57·49
Sat. ..	27	16	2·74	0·190	16	2·79
Sun. ..	28	16	7·30	0·158	16	7·34
Mon...	[illegible]	16	11·11	0·126	16	11·14
Tues ..	30	16	14·13	0·093	16	14·15
Wed...	31	16	16·37	0·060	16	16·39

TO CORRESPONDENTS, &c.

All Communications for this Journal should be addressed to the Editor, *at the Office*, 35, Northampton Square, Clerkenwell.

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The BRITISH HOROLOGICAL INSTITUTE, in fact, is intended to be an Association of the most prac useful kind to those connected with Time and Time-keeping, and is also calculated to be a of promoting a spirit of interest in the calling, and a wholesome pride of its high scientific cha which shall have the best results to all concerned.

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Further particulars may be obtained of the Hon. Secretary, at the Office of the In 35 Northampton Square, Clerkenwell, E. C.

The Horological Jo

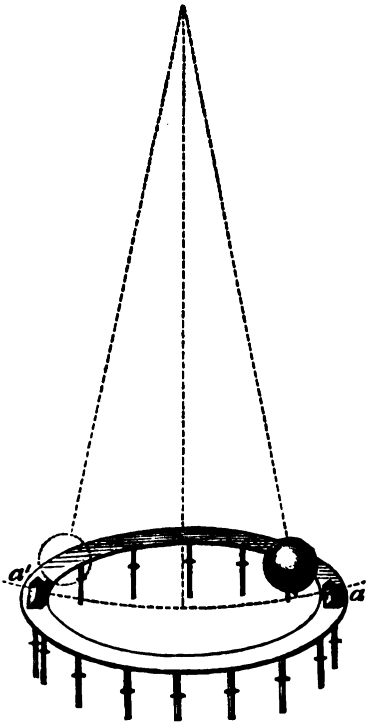
ELEMENTARY PAPERS

ON MECHANICS AND MATTER IN MOTION.

(*Continued from page* 18.)

NOTE ON THE PENDULUM EXPERIMENT.

The annexed figure will give a sufficient idea of the manner in which the pendulum experiment may be exhibited.



The interesting conclusion arrived at (p. 18, No. 26, Vol. iii.), in reference to the time in which the horizontal meridian line performs a complete revolution, is rendered somewhat obscure by a clerical error which we beg here te correct. Instead of "angle of deviation," (page 17, line 9), it should have been "angle at the base;" and a little lower down (line 18), "(x)" should be "or." The general conclusion arrived at in the text, is, that the angle of deviation of the horizontal meridian from its first position, is to the corresponding angle of revolution of the earth about its axis, as the sine of the latitude of the place is to unity, that is—

$$\frac{\text{angle of deviation}}{\text{angle of revolution}} = \text{sin. latitude.}$$

Hence the angle of revolution of the earth in any time being represented by x, we have generally—

$$x = \frac{\text{angle of deviation}}{\text{sin. latitude}}$$

So that when the horizontal meridian has completed an entire circuit, that is, when the angle of deviation is 360°, we have, as in the text—

$$x \; \frac{360^\circ}{\text{sin. lat.}} = \frac{24 \text{ hours}}{\text{sin. lat.}}$$

In the article here referred to, the name of "Foucault," has been inadvertently spelt "Faucault."

EXPLANATION OF TERMS IN NAUTICAL ASTRONOMY.

What are called the heavenly bodies appear to an observer on the earth to occupy a surrounding spherical concavity, at the centre of which our planet is placed. The phenomena of their rising and setting are appearances which necessarily present themselves in consequence of the rotation of the earth about its axis. This apparent concavity is called the celestial sphere, and the imagination traces upon it a variety of circles analagous to those conceived to be traced on the terrestial globe.

To assume, however, that what we call the starry heavens is really a concave sphere, whose centre coincides with that of the earth, and, therefore, that all the celestial bodies situated in it are at equal distances from that centre, would be to oppose what is well known to be truth; but the part of Astronomy with which we are at present concerned is occupied mainly with appearances, not with realities; or we should rather say, it is chiefly occupied with the consideration of those astronomical phenomena which are independent of actual distances, and which would equally present themselves were these distances other than what they are, or all, as they appear to be, the same.

The learner will readly perceive how this assumption of a surrounding celestial sphere is perfectly consistent with correct deductions in certain departments of astronomy—all those departments, for instance, which regard only the angular distances of the stars from one another, or from the imaginary circles before alluded to. The angular distance of two objects, whether on the earth or in the heavens, is the angle formed at the eye of the observer by lines drawn to it from the objects observed. If one or both of these objects move nearer to the eye, along the line of vision, or recede further from it, it is plain that the angular distance of the two must remain the same; the objects cannot in this way

increase or diminish their angular separation. The observer therefore may, if he please, consider the linear distances of the two objects from his eye to be the same.

Nautical astronomy has a good deal to do with observations of this kind—that is, with the measurement of angular distances; and but very little with linear distances. It would have nothing to do with linear distances if the earth were really a point, or if observations were all carried on at the centre instead of on the surface; but as it is, the semi-diameter of the earth is a linear measure of which cognizance must be taken, simply because appearances—in reference to the sun and moon, but not in reference to the stars—are different at the surface from what they would be at the centre. The angular distances are not exactly the same from the two points of observation.

What is here said of distances applies equally to magnitudes. The linear diameters of the sun and moon are not matters of concernment in nautical astronomy, only their apparent diameters, the diameters (taken in angular measure) they would appear to have to an observer at the centre of the earth.

All observations made upon these two bodies for the purpose of determining the latitude and longitude at sea, are reduced to what they would be if the place of observation were the centre of the earth. As to the stars, it is found that observations of them though made at the surface would require no modification if made at the centre, the radius of the earth being a mere point in comparison to the immense distance of the stars. We shall now define the principal circles of the celestial sphere.

Axis.—The axis of the heavens is the diameter of the celestial sphere, about which the apparent diurnal rotation of the celestial sphere takes place, and which, as we have seen, is due to the real rotation of the earth. The axis of the heavens is, therefore, only the axis of the earth prolonged; and the extremities of this axis (of course, the imaginary extremities) are the poles of the heavens.

Equinoctial.—The celestial great circle, to the plane of which the axis of the heavens is perpendicular, is called the equinoctial, or the celestial equator. It is traced out merely by extending the plane of the terrestial equator to the heavens.

Meridians.—The celestial meridians are in like manner marked out by extending the planes of the terrestial meridians; or they are semi-circles terminating in the poles of the heavens and perpendicular to the equinoctial.

Zenith. Nadir.—The zenith is that point in the heavens which is directly over the head of the spectator; or, if a straight line be drawn from the centre of the earth to any spot on its surface, and then prolonged to the heavens, the point on the celestial sphere which it would mark out is the zenith of that spot. The same line continued in the contrary direction would mark a point in the celestial sphere called the *nadir*. These two points, therefore, in reference to any place on the earth, are at the extremities of that diameter of the celestial sphere which is perpendicular to the plane of the horizon of that place: that is, they are the poles of the horizon.

Vertical Circles.—Vertical circles of any place are those which pass through the zenith and nadir of that place; they are all perpendicular to the horizon of the place, they are hence also called circles of altitude.

The altitude of a celestial body is its distance above the horizon measured on the vertical circle passing through the body. The complement of the altitude is the zenith distance. In the case of the sun and moon, the true altitude is measured from the rational horizon, and is a little greater than the altitude measured from the sensible horizon. In the case of the stars, the difference in altitude is insensible whichever horizon be referred to.

The most important of all the vertical circles of any place is the meridian. When a celestial object is on the meridian its altitude is the greatest which that object can possibly have; it is called the meridian altitude of the object.

The vertical circle which cuts the meridian at right angles and which therefore passes through the east and west points of the horizon, is distinguished next to the meridian. It is called the prime vertical. When a celestial object arrives at the prime vertical, it is either due east or due west.

Azimuth.—The azimuth of a celestial object is the arc of the horizon comprehended between the meridian of the observer and the vertical circle passing through the object. The arc of the horizon here spoken of is, of course, the measure of the angle at the zenith between the meridian and the vertical through the object. Vertical circles are sometimes called azimuth circles.

Amplitude.—Amplitude is also an arc of the horizon. It is the arc comprised between the east point of the horizon and the point where the body rises, or between the west point and where it sets; the former arc is called the rising amplitude of the body, and the latter its setting amplitude. Azimuth is measured either from the north or south

points of the horizon; amplitude either from the east or west. When we speak of the azimuth of a body, we refer merely to the azimuth of the vertical on which the body is, whatever its altitude on that vertical may be; when we speak of its amplitude, we refer exclusively to its position with respect to the east or west point of the horizon at rising or setting.

DECLINATON.—The declination of a celestical object is its distance from the eqinoctial, measured on the celestial meridian passing through it, and is either north or south. What is latitude as respects a point of the earth, is declination in reference to a point in the heavens. Celestial meridians are thus sometimes called circles of declination, and what are parallels of latitude on the earth become parallels of declination on the celestial sphere. The distance of an object from the elevated pole is the polar distance of it. It is the complement of the declination when the elevated pole and the object are both on the same side of the equinoctial, but when they are on contrary sides, the polar distance is the declination plus 90°. The elevation of the pole above the rational horizon of any place is always equal to the latitude of that place, for the latitude is equal to the distance of the zenith of the place from the equinoctial; the distance between the zenith and the elevated pole is, therefore, the complement of the latitude, and it is equally the complement of the elevation of the pole above the rational horizon; this elevation, therefore, is equal to the latitude of the place. Consequently, the depression of the equator below the horizon, or its elevation above the horizon in the opposite quarter, is the complement of the latitude, or (which is the same thing) the latitude is the measure of the angle whch the horizon makes with the equator. The celestial circles now defined have especial reference to the earth. The meridian and the equinoctial are merely extensions to the heavens of corresponding circles on the earth; and the vertical circles, or perpendiculars to the horizon, are imagined for the purpose of recording altitudes above the horizon, measured on the earth. But there are some circles peculiar to the celestial sphere; the principal of these are the ecliptic, or the circle of celestial longitude, and the perpendiculars to it, the circles of celestial latitude,

THE ECLIPTIC.—The ecliptic is the great circle described on the celestial sphere by the sun in its apparent annual motion about the earth; in reality, it is the path of the earth about the sun in the contrary direction; but, as already remarked, we are in this subject only concerned with the appearances. The ecliptic crosses the equinoctial at an angle subject to continuous but very small variation, determinable by observation. It is always given with the utmost attainable accuracy in the *Nautical Almanac*. The obliquity at present is about 23° 27½′.

The two points where the ecliptic crosses the equinoctial, are called the equinoctial points. The sun, in its apparent annual course, passes through these points about the 21st of March and the 23d of September, the former being the time of the vernal equinox, and the latter of the autumnal equinox; these names being given because the night is then equal to the day at all places where the sun rises and sets. This is obvious, because any point in the equinoctial, by the diurnal rotation of the earth or the apparent rotation of the heavens, is just as long below the horizon of any place as it is above it.

CELESTIAL LONGITUDE. — The circle on which the longitude of any heavenly body is measured is the ecliptic, not the equinoctial; and, as terrestrial longitude is measured from a fixed point of the equator, the point (with us) where the meridian of Greenwich crosses it, so celestial longitude is measured from a fixed point in the ecliptic, namely, the vernal equinoctial point, which is called the first point of the constellation Aries.

As respects terrestrial longitude, the fixed point from which the reckoning commences is only fixed for particular nations, each kingdom choosing its own; this is some inconvenience. But as respects celestial longitude, there is perfect uniformity of reckoning among astronomers; and this reckoning, unlike that for terrestrial longitude, is carried on in one direction round the celestial sphere, so that a body may have any longitude short of 360°. The ecliptic is conceived to be divided into twelve equal parts, called signs; a sign is therefore an arc of 30°. The twelve signs have the names and symbols following:

1. ♈ Aries (the Ram.)
2. ♉ Taurus (the Bull.)
3. ♊ Gemini (the Twins.)
4. ♋ Cancer (the Crab.)
5. ♌ Leo (the Lion.)
6. ♍ Virgo (the Virgin.)
7. ♎ Libra (the Balance.)
8. ♏ Scorpio (the Scorpion.)
9. ♐ Sagittarius (the Archer.)
10. ♑ Capricornus (the Goat.)
11. ♒ Aquarius (the Water-bearer.)
12. ♓ Pisces (the Fishes.)

The first six of these signs are to the north of the equinoctial and the others to the south; they are also called signs of the Zodiac,

the name given to a belt of the heavens 8° on each side of the ecliptic.

CELESTIAL LATITUDE.—As the ecliptic is the circle of longitude, the perpendiculars to it (that is the great circles through the poles of the ecliptic) are the circles of latitude. The distance of a celestial object from the ecliptic, measured on one of these perpendiculars, is its latitude; it is north or south, according as the object is on the north or south side of the ecliptic.

RIGHT ASCENSION.—The right ascension of a celestial object is the arc of the equinoctial intercepted between the first point of Aries and the declination circle, or meridian, passing through the object.

The learner will perceive that the first point of Aries is the starting point from which both longitude and right ascension are measured; and that what on the terrestrial globe would be longitude and latitude, on the celestial globe are right ascension and declination, the first point of Aries being substituted for the meridian of Greenwich.

GREAT CIRCLES, all of which pass through the poles of any of the more important great circles of the sphere, are frequently called secondaries to the latter. This is a very convenient term; thus vertical circles are secondaries to the horizon; meridians, or declination circles, are secondaries to the equinoctial; and circles of celestial latitude are secondaries to the ecliptic.

ON TIME.

The most important portion of time, in matters connected with nautical astronomy, is the *day* and its sub-divisions. There are several kinds of days referred to in astronomy; but the period occupied by a single rotation of the earth comprises, in each case, nearly the whole of the time so designated. If the heavenly bodies were all fixed, and the earth had no progressive motion, but only its present diurnal rotation on its axis, all days would be alike as to length, since the diurnal rotation is always performed in the same time; the interval between the departure from and the return to the meridian of any heavenly body would then be invariably the same. But as the earth is continually shifting its place in the orbit, and that by an amount which is not uniform, the interval between two successive passages of the sun over the meridian of any place is variable. This interval is called an apparent solar day.

APPARENT TIME.—When the sun is on he meridian of any place, it is apparent noon at that place; when it is in any other position, the angle between the meridian of the place and that on which the sun is, is called the hour angle from noon at that place and instant; this angle, converted into time, at the rate of 15° to an hour, is the apparent time at the place.

MEAN TIME.—As, on account of the inequality of the earth's motion in its orbit, the solar day is continually varying in length, a day that is the average or mean of these variable days is fixed upon for civil reckoning; and it is the length of such a mean day that is marked out by the twenty-four hours of a common clock or watch.

This length of time is called a mean or solar day; and any time shown by a correct clock or watch is mean solar time, or simply mean time. At certain periods of the year, the sun will thus arrive at the meridian before the clock points to twelve (XII.), and at other periods the clock will be in advance of the sun; the interval between the arrival of the index of the clock to XII., and of the sun to the meridian, is called equation of time. It is given for every day in the year, at page 1 of the "*Nautical Almanac*," for the meridian of Greenwich; that is to say, when it is apparent noon at Greenwich, on any day of the year, the almanac shows the time to be added or subtracted to obtain the corresponding mean time at that meridian.

SIDEREAL TIME.—A sidereal day is the time occupied by one complete rotation of the earth on its axis. This interval is ascertained by observing the time elapsed between two successive passages of the same fixed star over the meridian. Such is the immense distance of the stars that the earth's change of place from day to day produces not the slightest effect upon their apparent positions, which are preserved the same as if the earth were at rest. Whatever star be observed, and whatever be the place of the earth in its orbit, it is uniformly found that the interval of two successive passages of the star over the meridian is invariable, namely 23h. 56m. 4.09″ of mean time *

Besides the three kinds of day here described, there is also the lunar day, which is

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* The whole starry heavens have, however, a slow apparent movement, arising from a real motion of the earth distinct from its rotation on its axis. This motion causes the axis to describe a minute circle round the poles of the ecliptic in about 26,000 years; the effect is to cause the apparent approach of some stars towards the pole, and the recession of others. Thus the pole star, as it is called, has for many centuries been getting nearer to the pole; it is now about 1° 34′ from it. The star will continue its approach till within about 30′ and will then recede.

day. We have great need, and it is to be hoped we shall soon have, a ten hours' bill; in many of our shops the young girls are employed from 5 in the morning till 9 P.M.

8. The best watchmaking, of the first and second quality, has considerably improved during the last twenty years. Watchmaking in general is also divided into two qualities, the best of which may be made useful, the other is got up for commercial barter, and is only to deceive—it is a kind of Birmingham and Coventry ware.

9. The major part of the Swiss watches intended for England have cylinder [or horizontal] escapements, and are of middling good quality, from 14 to 18 lines diameter, gold or silver cases. Very few of the first and second quality made, to the order of but a few of the London shopkeepers. For the United States the watches are larger and stronger, with cylinder and lever escapements; chiefly in imitation of English workmanship with three-quarter plates, more especially the silver watches; for Russia as well as for England, mostly of the first and second quality, but also a great number of inferior; for Turkey, there is a special demand for heavy watches with much chasing, and dials marked with Turkish characters. The Chinese watches are usually bought in pairs, mostly silver and scarcely any gold; the Chinese prefer the blue steel movements, but their taste is improving.

10. In reply to a question as to the portions of work principally exported to England, these consist of a small quantity of movements carefully made with going-barrels; the escapements &c., are made in England. The Swiss likewise furnish, but in small quantities, repeating motions to carefully-made Lancashire movements, which are then transmitted to England to be finished.

SWISS AND ENGLISH WATCH-MAKING COMPARED.

Communicated to Mr. Herries *by* M. Drory *of La Chaux de Fonds.*

After some residence in New York, in 1817-18, I was struck with the clumsiness of English watches; and in writing to Switzerland, I said, "The work of these watches is an emblem of the character of the people who make them;" my opinion on this point has not been altered by forty year's subsequent experience, nevertheless this impress of nationality has under some circumstances been neutralised. Our common run of good watches destined for the English market and the United States are of a heavier make, and the English watches are more elegant than formerly. What principally distinguishes the Swiss from the English watches, is the great simplicity of the works of our cylinder escapement [or horizontal] watches, in which we have for the last forty years become convinced of the utter inutility of the fusee and chain, inasmuch as the compensation by friction on the axis of the balance or cylinder, nullifies the difference of motive power of the going-barrel propelled by a spring when constructed on the best principles.

The going fusee is one of the most beautiful and most useful pieces of mechanism of English watch-making, applicable to marine chronometers and astronomy, where the fusee becomes absolutely necessary because of the peculiar construction of the detached escapement. The fusee is also useful for all kinds of escapements, except for those of cylinder escapements, where it only takes up space and height, whilst at the same time it diminishes the motive power; and although watches with cylinders do not require or have the fusee, and still less the compensation balance (two pieces of mechanism of the highest merit), still, a simple watch when well-made, even of the ordinary quality, gives astonishing results for regularity, not varying in many cases a second in a week or even a month.* My first observation on this point was made in the case of a simple cylinder watch to which I had given every attention, and which made the voyage from London to Madras with a young man employed in the East India Company, in 1830; six or seven months afterwards, I received very satisfactory intelligence that the watch had kept better time with the chronometers on board, than all the other watches during the whole voyage.

The English watches with duplex escapements, and above all those with detached lever escapements, require the going fusee to produce equal results, all the other parts of their respective movements being equal in workmanship. The fusee and duplex escapements require more experienced and skilful workmen, by reason of the greater nicety requisite in their workmanship.

After the English marine chronometer, which is the first and grand work of the horological art, comes the duplex watch with compensation balance and going fusee, which gives results in regularity of time-keeping nearly approaching to the astronomical chronometer; then follows the watch with a detached lever escapement with fusee: this can be made of all qualities both in England and Switzerland, and at prices nearly equal in both countries—England having for a long time taken the lead, both as regard the going-fusee and the subdivision of workmanship, in the latter of which is classed the manufacture of detached lever escapments.

* *Sic.*—Ed.

REGULATIONS OF THE HOROLOGICAL SCHOOL, AS APPROVED OF BY THE MUNICIPAL COUNCIL IN 1856.

Management.

ART. 1. The committee of direction, appointed by the constituent body, shall meet in ordinary session once a month.

2. They may be specially convened by their president, or at the instance of three of the members of the council of administration.

3. The permanent direction of the schools is confided to a secretary named by the committee, this nomination is subject to the approval of the council of administration. The secretary is to receive a salary of 800f. (£32.)

4. Each member of the committee is expected to serve, in his turn, as class inspector. An acting-commissioner, for this purpose, is to be appointed weekly.

5. The acting-commissioners are to attend to all that relates to teaching, order, and discipline in the schools; they are to send in their respective reports to the committee.

6. No schoolmaster is to act on his own account in the schools; every infraction of this rule will be visited by the peremptory forfeiture of his appointment.

Secretaryship.

7. The duties of the secretary are as follows:—

(1.) To prepare the minutes, and to conduct the correspondence.

(2.) To purchase the tools, both ordinary and special; as likewise all requisite fittings.

(3.) To instal the pupils.

(4.) To notify the orders and decisions of the committee, and to see to the due execution thereof.

(5.) And generally, to see to the due observance of the regulations.

8. The secretary is to receive all payments, of which he is to keep account; he is to hand over the same to the cashier of the municipal administration.

9. He is likewise, through the masters, to receive all fines.

10. He is to collect and take care of the work done by the pupils.

11. He is to attend the school for at least one hour per day, in order to receive any communications, complaints, &c.

12. In the absence of a master, the secretary may be called upon to take charge of a class, without however being expected to give instruction.

13. He may, moreover, be directed by the committee, or any sub-committee, to draw up reports and minutes of proceedings.

Division and Orginization of the Classes.

Boys' School.

First Class.—Blanks and Pinions.*

14. The Blank Class is divided into inferior and superior divisions.

15. The eldest scholar in the lower division passes to the superior division whenever a vacancy occurs.

16. To pass into the next class, the pupil must have produced as follows: Three movements in the rough for cylinder escapements, two for anchor escapements, two for detached escapements [*èchappements à ressorts*] (one of which is with a fuzee), two for repeaters; moreover three sets of pinions with their wheel-work.

Second Class.—Finishing.

17. In this class the pupil finishes the rough pieces which he has made in the blank class.

Third Class.—Cadrature. [Repeating Motions.]

18. The pupil must make at least two cadratures [repeating motions]. The master makes him trace or draw the caliper for each of the above.

Fourth Class.—Escapement—Repassing.

19. The masters make the pupils trace the designs of the various kinds of escapements taught in this class.

First Section.—Cylinder Escapements.

20. The pupil makes the escapements for his three pieces and plants them; and moreover he makes a number of plantings,† to be determined by the committee of direction.

Second Section —Free Escapements.

21. The pupil is to complete and plant at least two anchor escapements, two with springs [detached escapements], and one duplex.

Third Section.—Repassing, and Chronometers.

22. The work in this section is not obligatory on the part of the pupil, being left to his option to engage in it or not, as he may feel inclined.

Young Girls' School.

First Division.—Works in the Rough.

23. The pupil is to make at least four complete sets of rough movements complete, and eight sets of barrels in the rough.

Second Division.—Finishing.

24. The pupil finishes up her four sets in the rough, and repasses her sets of barrels.

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* "*La classa de Blanc.*—This is a peculiar technieal term, denoting the first, or rough pieces, of a watch.

† "*Plantages.*"—Laying down the pieces in their proper positions.—ED.

miss any pupil who may set a bad example learned in a few months without the help of

a master. Thus, like most other eminent mathematicians, he may be considered in a great measure, as self-taught; but, contrary to the usual course of such studies, his early turn for astronomy led to his mathematical attainments. In 1749, he was entered at the university of Cambridge; he was first placed at Catherine Hall, but soon after removed to Trinity College, where he pursued his favourite studies with increased success; and, on taking his first degree, received distinguished honours from the university. He took his several degrees at the following periods, A.B. in 1754, A.M. in 1757, B.D. in 1768, and D.D. in 1777. In 1755 he was ordained to the curacy of Barnet where he officiated for some time, and where he devoted most of his leisure hours to the study of practical astronomy. About this period he connected himself with the great astronomer Bradly, for whom it appears he made different calculations of importance. In 1758 he became fellow of Trinity College, Cambridge; and the next year he was elected a fellow of the Royal Society. But it was in the year 1761 that his real astronomical career began, when he was chosen to go to the Island of St. Helena, to observe the transit of Venus over the sun's disc. To render this voyage the more useful, he offered to the Royal Society to make observations on the parallax of Sirius. This beautiful star had been often observed by La Caille, at the Cape of Good Hope. Dr. Maskelyne, from calculating these observations, thought he saw proofs for the existence of a parallax of 4′. 5″, from which it would result that Sirius is not so far distant from the earth as was commonly imagined. Clouds prevented the observation of the transit of Venus, which had given occasion to the voyage; but Maskelyne, furnished with an excellent pendulum of Shelton, which had been regulated at Greenwich by Bradly, and which had been transported with the greatest possible care, determined the number of oscillations which it made less in St. Helena than at London, in order to deduce from that observation the diminution of gravity. The secondary object of the voyage, the parallax of Sirius, likewise failed; but it produced an observation both curious and useful.

To know if Sirius had a sensible parallax, it was necessary to have a more perfect instrument than that of La Caille, it was necessary to observe the stars in peculiar situations. The first of these requisites depended upon the artist; the second upon the astronomer. The Royal Society had got a sector made on purpose, which was only finished just when the vessel sailed, and could not be verified at Greenwich. What was the surprise of Maskelyne when he found that this instrument, destined for the most delicate researches, gave from one day to another differences of 10″, 20″, and even 30″, in the measure of the same angle! In examining with care what could be the cause of these singular variations he discovered it without difficulty, made himself certain of it by various proofs, and endeavoured to correct it, but could succeed only imperfectly. He reduced the error to 3″, which was far from being sufficient for the object he had in view. This obliged him to renounce his second project. The result, however, was an improvement in the construction of these astronomical instruments. But his voyage answered a more important purpose, and far more useful to his country, than that originally intended; it afforded him an opportunity of taking lunar observations, which are now for the first time made with effect. This method of finding the longitude at sea had been long contemplated as a grand desideratum in navigation; and plans and preparations had been made for the purpose by Hamstead, Newton, La Caille, Euler, Halley, Bradley, Mayer, and others; but the honour was reserved for Dr. Maskelyne, to reduce their theories to successful practice. This he was enabled to do by means of Hadley's quadrant, recently invented; and also by Mayer's Lunar Tables, for which a parliamentary reward of £3000 was afterwards given, on Dr. Maskelyne's report of their correctness. During the voyage, both outwards and homewards, he exercised the officers on board in taking lunar observations; and taught them to clear the distances from the effects of parallax and refraction, and thence to find the longitude within certain limits. While at the island, he made accurate observations on the tides, the variation of the compass, and the comparative gravity of bodies there and at London. He also observed the annual parallax of Sirius, and the horary parallaxis of the moon. The chief results of these operations are inserted in the philosophical transactions of the above period. Soon after his return from St. Helena, he published his well-known work, entitled *The British Mariner's Guide*, which contained, among various new and practical illustrations, and articles in nautical astronomy, rules and examples for working the lunar observations; but in order to shorten and simplify these laborious operations, other tables and calculations were still wanted, which he afterwards supplied by his *Nautical Almanac*, and requisite tables. In 1763, he made a voyage to Barbadoes, in order to examine the goodness of Harrison's time-pieces. The report

which he made at his return, though favourable in general to the celebrated artist, whose invention he had subjected to the most severe test, was far from satisfying Harrison, who attacked him in pamphlet. Maskelyne wrote a reply to this attack. Naval men and philosophers took part with one side or other, according to their ideas and habits. M. de Fleurieu, particularly connected with F. Berthoud, and devoted to the cause of the time-pieces, forgot perhaps on this occasion his accustomed moderation. It was a dispute between two useful methods, calculated to assist each other. Maskelyne did not find the time-piece sufficiently certain, nor sufficiently regular. Harrison affirmed, not without reason, that they were within the limits prescribed by the act of parliament. He demanded the whole reward, which was afterwards given him, though at first he received only the half. While pleading his cause he attacked the astronomical methods, availing himself of some admissions of La Caille, who, with his incorruptible integrity, while boasting of the method of the lunar distances admitted that they had sometimes led him into error. Maskelyne proved by his own observations, that the errors are much diminished when better instruments are employed than those used by La Caille, such as were beginning to be constructed in London. It is possible that, in this dispute between mechanics and astronomy, both sides went a little too far. The time-pieces performed everything demanded by act of parliament of 1714; and there can be no doubt that, if they had been presented at that time, Harrison would have obtained the whole reward without difficulty. But fifty years afterwards, when the instruments were much more complete, when the lunar observations had received unexpected improvements, was it not excusable to demand a little more accuracy? The time-pieces, by the facility they offered, were likely to seduce maritime men, who are usually enemies to long calculations; but their exactness, it was said, could only be trusted in short voyages; and that in less ordinary circumstances, and in long navigations, the method of lunar distances had an incontestible advantage. This at least was Dr. Maskelyne's opinion, and from this time he appears to have taken a dislike to watchmakers. When the proprietors of *Dr. Rees's Cyclopædia* sent an artist to Greenwich, a few years since, to request the favour of being allowed to examine Harrison's time-piece which is there preserved, and to make some drawings from it, Dr. M. would not permit any part of it to be inspected; and even when a question was asked as to the portions of parliamentary reward which Harrison had received, a question of common curiosity, and so easily answered by one who was so fully acquainted with the whole transactions, "the doctor, with his usual reserve, declined giving any information on the subject," see *Chronometer* in *Rees's Cyclopædia*; and the article, *Horology*, vol. x., pp. 349, 355. In the year 1764, the office of Astronomer Royal became vacant by the death of Mr. Bliss, who had survived his appointment, as successor to Mr. Bradly, only two years. Dr. Maskelyne's celebrity immediately pointed him out as the most competent person to fill the situation. His reputation stood very high in the Royal Society, both as a profound mathematician and an able astronomer; while his experience at sea, and above all, his success in establishing the lunar observations, seemed to render him peculiarly well qualified to carry into effect the purpose for which the Royal Observatory had been established, that of preparing tables for finding the longitude at sea. Through want of this knowledge, it was said, that not only single ships, but whole fleets, had been lost, which induced government to offer immense rewards for practical methods of determining the problem. When Mr. Flamstead, the first Astronomer Royal, was appointed to the office in 1675, he was directed by King Charles the Second "to apply himself with diligence to the rectifying the tables of the motions of the heavens, and the places of the fixed stars, in order to find out the much desired longitude at sea, for the perfecting the art of navigation." These were the words of his commission, which have been since continued to his successors. Thus, the office of Astronomer Royal was justly considered of great national importance; and Dr. Maskelyne's appointment to it, which was announced in the *London Gazette*, Feb. 16, 1765, gave universal satisfaction. It should be noticed, that the office includes a seat at the Board of Longitude, *i. e.* a board formed of commissioners, who are appointed "for examining, trying, and judging all proposals, experiments, and improvements, relating to the longitude." Soon after this appointment, he laid before the Board of Longitude the plan of an annual publication, to be entitled *The Nautical Almanac, and Astronomical Ephemeris*. The first volume was for 1767; and it was continued, under his direction, up to the year 1816, inclusive, making in the whole fifty volumes, a lasting monument of labour and profound learning. It is universally allowed to be the most useful work on practical astronomy ever published. In such high estimation has it been held by foreign

astronomers, that they have generally and implicitly adopted its computations, and acknowledged its superior accuracy.

M. Lalande, in giving an account of similar publications, says "Le Nautical Almanac de Londres est l' Ephemeride la plus parfait qu'il y ait jamais eu." In 1767, he published an auxiliary work, entitled "Tables requisite to be used with the Nautical Almanac, in order to find the latitude and longitude at sea." This performance, well known to seamen by the name of "The requisite tables," has passed through several editions, and has been successively enlarged, particularly by different methods of working the lunar obsevations, by Messrs. Lyons, Dunthorne, Witchell, Wales, and by Dr. Maskelyne himself; and it has been improved by the latitudes and longitudes of places supplied by Captain Cook, Captain Huddart, Messrs. Bailey, Wales, and other scientific navigators. Some time after this, he published Mayer's Tables, with both Latin and English explanations, to which he added several tracts and tables of his own, and prefixed to the whole a latin preface, with the title, Tabulæ motuum Solis et Lunæ, &c. It was published, like the foregoing works, by order of the Commissioners of Longitude; and the various other publications issued by that board during his time were also printed under his inspection, and are too numerous to be here stated. Another important and laborious duty that devolved on him in consequence of his office was, to examine the pretentions of the various candidates who claimed the parliametary rewards for new or improved methods of finding the longitude.

It may be observed, that his appointment took place at a period peculiarly interesting in the history of astronomy. His success in introducing and promoting the lunar observations greatly excited the public attention to the subject of the longitude, which was rendered still more interesting by the great rewards held out by parliament for further improvements in the problem, whether by astronomical or mechanical methods. These offers, united with the powerful motives of honour and emulation, called forth during several years many extraordinary efforts of genius, and produced useful inventions both in arts and sciences, and particularly in the construction of time-keepers. The parliamentary offers likewise encouraged numerous candidates of very slight pretensions, and even visionaries whose applications became very troublesome. The claims of all were referred by the Board of Longitude to the Astronomer Royal, by whom scientific plans were examined, and the rates of chronometers ascertained. Thus by his office he was constituted arbiter of the fames and fortune of a great number of anxious projectors; and it is easy to conceive how arduous as well as unpleasant such a duty must have been. It was not indeed to be expected that the sanguine hopes and self-love of such a variety of candidates could be gratified, with justice to the high trust and confidence thus reposed in him; and hence complaints were frequently heard, and pamphlets published, expressive of discontent and disappointment. Appeals even were made to parliament, but whatever difference of opinion might have then existed, time and experience have since fully proved the truth and impartiality of Dr. Maskelyne's decisions. In giving a general view of his labours at the Royal Observatory, we shall begin with his publication of the Greenwich observations, which were printed in 1774, by command of his Majesty. The first volume began with the observations of 1765, and they have been continued annually since. M. Lalande in mentioning this performance in 1792, calls it "le recueil le plus precieux que nous ayons." Since that period they have been considerably improved, and are universally allowed to possess an unrivalled degree of accuracy. His catalogue of the right ascension and declinations of thirty-six principal fixed stars, with tables for their correction, is a most useful and important performance, and is adopted in all observatories. It is mostly distinguished by the appellation of Dr. Maskelyne's Thirty-six Stars. His observations of the sun, moon, and planets, are equally esteemed, and have been made the basis of the solar and lunar tables lately computed in France according to the theory of M. Laplace; and which are republished in Professor Vince's Astronomy, Vol. III. The solar tables were calculated by M. Delambre, and the lunar by M. Burg; copies of which were transmitted to Dr. Maskelyne, by order of the French Board of Longitude, with a grateful acknowledgment of the important assistance derived from his Greenwich observations. M. Delambre observes, that the establishment of the Board of Longitude in France, the observatories of Paris and Greenwich, are directed nearly to the same objects; and furnished with instruments equally good, they produce annually collections of observations equally precise, which would serve mutually to verify one another if there were occasion. They serve as a supplement to each other, when the clouds which cover one observatory do not extend likewise to the other. The communications are continual, and the obligations reciprocal. If the French tables are founded

in a great measure upon the observations of the English, on the other hand the calculations of the English are founded upon the French tables. But the latest tables have been verified by as many French as English observations.

Dr. Maskelyne no more quitted his observatory. In 1769 he remained in it to observe the transit of Venus, though only one phase was visible at Greenwich; but he drew up instructions for the astronomers whom Great Britain sent to different countries, he collected their observations, and deduced from them the parallax of the sun, and its distance from the earth. His result was the same as that to which Dusejour came, by comparing the totality of the observations of the two transits of 1761 and 1769. He made many of the most interesting and most difficult observations himself, as those of the moon; but necessarily confided to his assistant those which were more easy and less essential. He followed with inflexible rigour the methods established by his celebrated predecessor Bradley, whom he even surpassed in the exactness of his daily observations. He brought to perfection the method of Flamstead, of determining at once the right ascensions of stars and of the sun. It may be said of the observations that he published, that, if by any great revolution the sciences were completely lost, and this collection preserved, there would be found in it sufficient materials for rebuilding almost the whole edifice of modern astronomy, which cannot be said of any other collection; because to the merit of an exactness which has been seldom attained and never surpassed, it adds the advantage of a long series of observations. Its precision is so great, that it is very improbable that much can be added to it. The observations are excellent for the time in which they were made, and this time is the period in which they approached the nearest to perfection. They will only increase in value as they increase in age; which unfortunately is not true either with respect to the observations of Tycho and Helvetius, or to those of Flamstead and La Hire, which, when made, possessed all the exactness of which any idea could be formed; but which, though not far removed from the present age, never can enter into any comparison with the observations of the great astronomers of the eighteenth century. Dr. Maskelyne corresponded with all the astronomers of the world. To be convinced of it, we have only to run over the memoirs of philosophers of every nation which he presented to the Royal Society. He himself did not publish quite so often as could have been wished; but it is very difficult for an astronomer, charged with the duty of observations to be repeated every day, and almost every moment, to undertake great theoretical researches, which he is under the necessity of interrupting almost every instant. The writings which he has left are remarkable for just ideas and an enlightened criticism. Such is a Dissertation on the Equation of Time, where he has pointed out, with the requisite delicacy, a mistake of La Caille, and another less important mistake of Lalande. Lalande received very well the lesson which he thus got; but Bernoulli having inserted, seven years after, a translation of Dr. Maskelyne's memoir in his collection for astronomers, one of Lalande's pupils (D'Agelete) took up the cause of his master in a manner that might have produced a coldness between the parties concerned. The quarrel, however, had no consequence; and the two astronomers corresponded as usual. Some doubts having been raised respecting the difference in latitude and longitude between the observatories of Paris and Greenwich, Dr. Maskelyne, to whom the observations were sent, showed with his usual moderation, that the doubts were improper; but he did not oppose the methods proposed to obviate them. It was upon this occasion that the English, who had hitherto done nothing respecting the grand geographical operations in which the French had distinguished themselves, signalized themselves in their turn by methods which surpassed every thing that had been hitherto done. It was then likewise that M.M. Cassini and Legendre made the first trial of the circle of Borda. Boujuer, at the end of his measure of a degree in Peru, had endeavoured to determine the attraction of mountains, and the quantity which they drew the plumb line of the sector from the perpendicular direction. He had found a real and indisputable attraction; but one half less than ought to have resulted from the size of the mountain. Hence, he concluded that it was hollow within, and undermined by a volcano. Doubts might be entertained of a result obtained by means of instruments of middling goodness. Boujuer had himself expressed a wish that the experiment were undertaken in Europe with more care and with better instruments. Dr. Maskelyne undertook this inquiry, with the sector that he had with him at St. Helena, after having corrected the suspension, and altered the division. He made choice of Schehallien, a mountain in Scotland. It will be necessary to consult his memoir, in order to see the care and the pains which this operation cost him, which appears so easy. But it must be observed, that the laborious parts of the calculation, from Maskelyne's data, were com-

pleted by Dr. Hutton, then a very young man; and for which the Royal Society voted a gratuity of £250. From these observations and calculations it appears, that the mean density of the earth is to that of water as 9 to 2, and to that of stone as 9 to 5; whence it is presumed that the internal parts contain some large quantities of metals.

In 1792, Dr. Maskelyne published Mr. Michael Taylor's Table of Logarithins, a laborious work, and an uncommon monument of persevering industry. The author had been encouraged by the doctor in the execution of it; and, having died when only a few pages remained unfinished, Dr. Maskelyne brought it to a conclusion, and prefixed to it a very masterly introduction, containing precepts for the use of it. Dr. Maskelyne is said to have been the inventor of the prismatic micrometer; at any rate, the idea of employing a double refraction belongs to him, and Boscovich acknowledges it. As he set a high value on the excellent instruments which he used, he did his utmost to preserve and improve them, by making such additions as his experience and skill in optics suggested. He found the inconvenience of narrow openings, then used in all observatories, and therefore he had those of Greenwich enlarged. It had been lately suspected that his quadrant had become less exact in consequence of the friction which it had undergone during its continual employment for more than fifty years. It was very natural that an astronomer, who always paid the same degree of attention to his observations, and who did not perceive in his instrument any mark of old age, should not be the first to detect changes in it, very slight in themselves. Other instruments, more modern, and of a different construction, and placed in the hands of attentive astronomers, occasioned the first suspicions. It is true that the small variations which appear to have been observed may be accounted for in such a way as to acquit the quadrant at Greenwich of inaccuracy. Messrs. Bessett and Oltmans gave explanations of them not deficient in probability; but the most certain method was to procure new instruments. This was what Dr. Maskelyne did. He employed the celebrated Troughton to make a grand and superb circle, which he had not the pleasure himself of placing in his observatory; but which has been put into the hands of his successor, Mr. Pond, who will no doubt make the public acquainted with the faults which time had produced in the Greenwich quadrant, and will inform us what corrections must be made in the latter observations at Greenwich, to render them as valuable as the more early observations at Greenwich.

Dr. Maskelyne had good church preferment from his college, and his paternal estates (for which he was the last male heir) were also considerable; he married, when rather advanced in life, a young lady of large fortune, the sister and co-heiress of Lady Booth, of Northamptonshire, by whom he had one daughter, whose education he superintended with the fondest care. These ladies survived him; and also his sister Margaret, who was married to the late Lord Clive. Dr. Maskelyne died on the 9th of February, 1811, in the 79th year of his age. His health had previously declined for some months, and he contemplated his approaching dissolution with pious resignation, and with a lively hope of being admitted into the presence of that Deity whose works he had so long studied and so ardently admired. His favourite science tended the more strongly to confirm his religious principles; and he died, as he lived, a sincere christian. *Eulogy read in the National Institute by Delambre. Rees' Encyclopædia. Monthly Magazine.*

ART EDUCATION.

From "The Athenæum," Oct. 6th, 1860.

The appeal is made to the inhabitants of the North Eastern district of London, and all who are interested in the diffusion of art education, to assist in procuring for that locality the advantages of a self-supporting School of Art. It is proposed to erect, in a central and eligible situation, a building that shall comprise class-rooms for drawing, painting, and modelling, and also include a museum and picture gallery. With the proposed institution, "The Finsbury School of Art" will be incorporated, and its title be "The North London Gallery, Museum, and School of Art, in connection with the South Kensington Museum." It will be entitled to be supplied periodically with objects of art from the national collection. The buildings will be open to public inspection on the same plan as the South Kensington Museum. The service that latter institution has rendered to the public is undoubted; but its situation is too remote from what is really the most densely populated section of London, and the precise section, moreover, in which men of the class reside who are really in need of art education, and who practise art manufacture beyond all others, for in truth, gold and silversmiths, jewellers, watch manufacturers, engine turners, chasers, engravers, and several other

branches of art manufacture are identified with the district; under these circumstances it is proposed to establish the schools, &c. in question. The museum will likewise contain specimens of the animal, vegetable and mineral kingdoms, and of manufactures obtained from them. There will be evening classes, and a ladies' morning class; the fees as fixed by the Committee of Council on Education. Between £4000 and £5000 will be required for the new building; and the committee intend, when the scheme is more advanced, to apply for the customary government aid. By a minute of council, no grant for building purposes will exceed 25 per cent of the outlay.

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

(*Continued from page* 23.)

1839, December 11.—No. 8308.

GOUGY, Pierre Frederick.—The introduction into watches, clocks, and other time-keepers, of a supplementary second hand, so adjusted by mechanism that it may be stopped while the other second hand is going, and on being set free will recover its original position, and rotate as before along with the other.

[Printed, 7*d.* See Mechanics' Magazine, vol. 33, p. 65; and Inventors' Advocate, vol. 2, p. 386.]

1840, March 7.—No. 8418.

MOLYNEUX, Robert.—The addition to the compensation balance, of a supplementary compensation balance, consisting of two pieces with projecting parts, which, when the balance is compensated, bank in contact with the inside of the balance rim, either at the parts near the arms or at the free ends according as the supplementary compensation is for higher or lower temperatures. The inventor also produces the same effect independently of the action of the balance rim.

[Printed, 5*d.* See Inventors' Advocate, vol. 3, p. 197.]

The Clock Bells of Westminster.—A trial of the musical sounds emitted by the four chime bells of the great clock, and also the great bell itself, took place before several musical and scientific gentlemen, under the direction of Professor Airey, for the purpose of registering the various sounds, and Mr. Poole, a C.E., but a gentleman well versed in sounds, he having, it was stated, written on the subject. The experiment was conducted in a purely scientific manner. Mr. Fincham was stationed with other officials in the clock tower, and the gentlemen who were to test the range and tone of sound in the interior yard of the House of Commons, where an inverted barrel was placed to give effect to the sounds of their tuning forks and other instruments for testing sound. Mr. Fincham acted upon preconcerted signals from the yard, and answered from the tower. The first bell was struck, and when its sound had been accurately registered, on signals, the 2nd, 3rd, and 4th bells were tested in like manner, after which, on signal, several strokes from the inner hammer of the great bell were sounded, and, although it has a wide open seam and a hole six inches deep, it boomed forth most musically. A word as to lighting the great clock. It is illuminated from eleven o'clock till two only, when the majority of the people are in bed, instead of from eight to four, during which, at the present time, the hours are in darkness.

EQUATION OF TIME TABLE

For November 1860.

Day of the Week	Day of Mnth	At Apparent Noon — Equation of Time to be *subtracted* from Apparent Time.	Difference for One Hour.	At Mean Noon — Equation of Time to be *added* to Mean Time.
		m. s.	s.	m. s.
Thurs.	1	16 17·81	0·026	16 17·82
Fri....	2	16 18·44	0·008	16 18·44
Sat. ..	3	16 18·25	0·043	16 18·24
Sun. ..	4	16 17·22	0·079	16 17·20
Mon...	5	16 15·34	0·114	16 15·31
Tues..	6	16 12·61	0·150	16 12·57
Wed ..	7	16 9·03	0·185	16 8·98
Thurs.	8	16 4·59	0·221	16 4·53
Fri. ..	9	15 59·28	0·257	15 59·22
Sat. ..	10	15 53·11	0·293	15 53·03
Sun. ..	11	15 46·08	0·329	15 45·99
Mon...	12	15 38·19	0·365	15 38·10
Tues..	13	15 29·44	0·400	15 29·34
Wed ..	14	15 19·85	0·435	15 19·74
Thurs.	15	15 9·41	0·470	15 9·29
Fri ...	16	14 58·14	0·504	14 58·01
Sat ...	17	14 46·03	0·538	14 45·90
Sun. ..	18	14 33·12	0·572	14 32·98
Mon...	19	14 19·39	0·605	14 19·25
Tues..	20	14 4·87	0·638	14 4·72
Wed ..	21	13 49·56	0·670	13 49·40
Thurs.	22	13 33·47	0·702	13 33·31
Fri. ..	23	13 16·62	0·733	13 16·46
Sat. ..	24	12 59·02	0·764	12 58·86
Sun. ..	25	12 40·67	0·795	12 40·50
Mon...	26	12 21·59	0·825	12 21·42
Tues ..	27	12 1·79	0·855	12 1·62
Wed...	28	11 41·28	0·884	11 41·11
Thurs .	29	11 20·07	0·912	11 19·90
Frid ..	30	10 58·18	0·939	10 58·01

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ELEMENTARY PAPERS

ON MECHANICS AND MATTER IN MOTION.

(Continued from page 39).

On the Pendulum—*continued.*

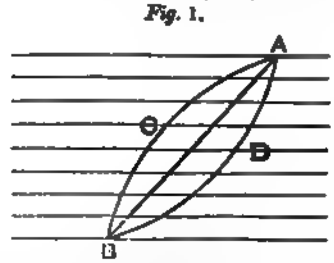
It is evident from what has been previously stated, that we can so proportion the length of an inclined plane to its height, as to make the rate of movement what we please. Thus, if we gradually diminish the height, the descent will be slower and slower, until the plane becomes level, in which case there will be no movement at all; or we may gradually increase it until the plane becomes perpendicular, and then the body upon it will fall freely, according to the regular law. In any case there will be precisely the same proportional acceleration of the movement, during the descent, as when the body is falling freely; but the rate per second will be diminished according to the amount of inclination, just as it is in Attwood's machine,* by the partial counterpoise of the weight. As the rate of movement which the body has acquired at the end of its descent, is always that which it would have gained when falling perpendicularly through the same height, whilst the time which is occupied in its fall depends upon the length of the plane, it is obvious that the rate per second at which the body commences its movement will depend upon the proportion between the height of the plane and its length. Thus, supposing that the plane be 144 feet high and 288 feet long; a body would require only 3 seconds to fall through its height perpendicularly; but would occupy 6 seconds in rolling down the incline, commencing with a velocity of only 8 feet per second instead of 16. Its rate of movement will increase in regular proportion, thus: falling 8 feet in the first second, it will fall (4 × 8) 32 feet in two seconds, (9 × 8) 72 feet in three seconds, (16 × 8) 128 feet in 4 seconds, (25 × 8) 200 feet in 5 seconds, and (36 × 8) 228 feet or the whole length of the plane in 6 seconds. At the end of this time it will have acquired the velocity of (6 × 2 × 8) 96 feet per second, which would have been acquired by a body falling perpendicularly in 3 seconds. But, suppose that the plane had a length equal to 16 times its height,—the body would then require 16 times 3 seconds for its descent, and would only commence at the rate of 1 foot per second. The whole space passed through in 48 seconds is found by multiplying the square of 48 by 1 foot.

* See p. 45, on "Attwood's Machine."

The velocity acquired at the end of the descent is found by the same rule to be (48 × 2 × 1) 96 feet, the same as that of a body falling through a steeper plane or through the perpendicular. Hence we see that, when a body descends along an inclined plane, its rate of motion is diminished in the exact proportion in which its length exceeds its height; but that the law of acceleration, owing to the continual action of the force of gravity, is exactly the same as if the body were falling freely. It is easy to understand why this diminution of rate should take place; for when a body is resting on a level surface the whole of its weight is resting *on that surface*, and its gravity cannot therefore put it in motion; on the other hand, if the plane be raised into the perpendicular position, none of the weight is supported by it, and the force of gravity acts freely *on the body*. In all intermediate positions, a larger or a smaller part of the weight is supported, in proportion as the plane approaches the horizontal or the perpendicular position. Now the action of the force of gravity upon a part of the body has to put in motion the whole of it (just as in Attwood's machine), and thus the rate of its movement must be diminished according to the proportion between the moving power and the amount to be moved. How this proportion is to be estimated will be explained when the Inclined Plane is considered as one of the mechanical powers.

When a body moves down a curved surface, however, the case is materially altered. In the inclined plane the amount of descent, or fall, is the same in every part of the plane, and consequently the acceleration of the body's motion is uniform. But this is not the case in a curved surface, as will be evident from a little consideration. In the accompanying figure (*fig.* 1), the straight

Fig. 1.

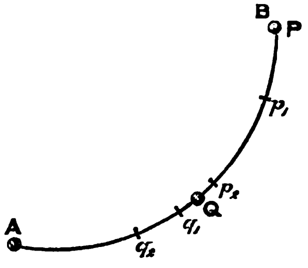


line A B represents an inclined plane which is divided into eight portions, by horizontal lines drawn at equal distances; these portions are equal, so that the length of the plane everywhere corresponds with its height. But A C B and A D B are two portions of circles, beginning and ending at the same points; and the movement of a body along surfaces having these curvatures will be very

different from that of a body descending the plane A B; for it is shown by the figure, that at the beginning of its course, the curve A C B departs but little from the level; so that for a body to descend through one-eighth of its height, it must pass through much more than one-eighth of its length; whilst in the latter part of its course, its rate of descent is much more rapid, since it approaches more nearly to the perpendicular. Precisely the opposite is the case in regard to the curve A D B; its rate will be at first much more rapid than on the inclined plane, but it will afterwards be increased in a much less degree. The precise rate of a body descending through either of these curves, or any others, can be determined by mathematical investigations, which would be here out of place; but the curious result is obtained from all,—that, whatever be the nature of the curve, the velocity which the body has acquired at the end of its descent, is exactly that which it would have acquired in its descent along an inclined plane of any length but having the same height, or in its perpendicular fall through a space equal to the height of the plane.

It is not difficult to understand, that a curve might be so formed that the amount of its inclination at every point shall be in proportion to the distance (along the curve) of that point from the bottom, as, for instance, that half-way up the ascent the curve shall rise 1 inch for a foot of its length, whilst at twice the distance from the bottom the curve shall rise 2 inches for a foot of its length. Such a curve will have this remarkable property, that from whatever part of it a body will be allowed to descend it will reach the bottom in the same time.

Fig. 2.



This will be easily understood by refernce to the subjoined figure (*fig* 2). Let A B be the curve; and Q and P two bodies so placed that the distance P A (measured along the curve) is equal to twice Q A; then, by the nature of the curve, its inclination at the point P is twice as great as at Q, and a body which begins its descent at P will have twice the rate of the body which starts from Q. In the first second, therefore, P will have fallen twice the distance, reaching P 1, whilst the body Q reaches only q 1; and as the distance P p 1 is twice Q q 1, the remaining distance A p 1 is equal to twice the remaining distance A q 1; hence the acceleration during the next second of the motion of the body P will be twice that of the body Q; and P will move through the space between p 1 and p 2 whilst Q moves only half the distance, that between q 1 and q 2. In the same manner, the distances which remain to be traversed by P and Q, during the third second, are still as 2 to 1; and the rate of P being all along double to that of Q, these distances will be performed in equal times, so that the two bodies will arrive at A together.

The same principle holds good in regard to bodies commencing their descent at any part of the curve. Thus, suppose Q to commence near the bottom, and P at a distance (measured along the curve) equal to six times that of Q; then, the inclination, or fall, of the curve at P being six times that of the curve at Q, the rate of a body starting at P will be six times that of a body starting at Q; and as, from the nature of the curve the acceleration of motion during each succeeding second bears the same proportion in both cases to the rate with which they started, the body P will in each second move six times as fast as Q in the corresponding second, and will therefore arrive at the bottom at the same time with it. Such a curve is called an isochronous curve; and it is that known to mathematicians as the cycloid. It is precisely the curve which any point in the circumference of a carriage-wheel describes, when its motion round the axle is combined with its forward movement along the road, and it may be marked along a board, by fixing a pencil or piece of chalk on the circumference of a wheel, and making the latter roll on any straight edge.

(*To be continued.*)

In the Academy of Sciences at St. Petersburg, is a Repeating Watch about the size of an egg; within it is represented our Saviour's tomb, with the stone at the entrance, and the sentinels guarding it. While the specatator is admiring this curious piece of mechanism, the stone is suddenly removed, the angels appear, the women enter the sepulchre, and the same chant is heard which is performed in the Greek church on Easter Eve.

ON THE CALCULATION OF TRAINS BY APPROXIMATION.

A NEW METHOD, BY M. BROCOT.

*Communicated to the Society of Clock-makers of Paris, at their Meeting of the 10th June, 1860.**

GENTLEMEN,

I am about to explain to you a new mode of calculating trains by approximation.

I think I ought, previously, to explain how, and upon what occasion, I was led to this discovery.

Some years ago I was employed to repair some pendulum clocks which pointed out certain appearances in the heavens: in each of them a part of the train had been removed, and the owner of these clocks was desirous that they should be restored to their original condition.

As the means which I had then at my disposal appeared insufficient, I thought that by referring to books on Clock-making I should find directions necessary for performing this work with all the accuracy and rapidity possible.

I particularly studied Janvier, as an author who had given most attention to this question, and I exerted all possible perseverance in trying to understand him. My labour was entirely thrown away, as the methods set forth in his work were not practical, and could be of no further use than to serve as exercises for those who had nothing further to learn.

After many trials, I found at last the numbers that I wanted; but after my first attempts, I saw at once that the closest approximation depended on a certain skill in making the calculations; and I then thought it would be interesting and useful to establish a method free from all doubtful trials, and at once enabling the operator to discover among the practical results, those which were most suitable.

I imagined, in succession, several modes of proceeding, but I was obliged to give them up, one after the other, as they did not realize, by a direct method, the plan that I wished to establish.

At length my researches were crowned by complete success; but although the method was established, there still remained a task very laborious to accomplish, which was the theoretical development of this method.

This work is now finished, and nearly ready to be delivered to the printer.

* Translated for THE HOROLOGICAL JOURNAL, by C. A. HOLDSTOCK, 25, Upper North Place, Gray's Inn Road.

It is divided into three parts:

The first is entirely theoretic; and in this the propositions are demonstrated upon which the operations are founded.

In the second, all these operations are pointed out, in the most practical manner that I could imagine; and at the end are numerous examples of their application.

The third consists of a Table for the conversion of decimals into vulgar fractions; the object of this table is to shorten the work and to abridge part of the calculations.

The theoretical principles, by the table, would lead to long explanations; and the time of the meeting being too short to allow me to enter upon this subject, I must confine myself to some practical explanations.

It is well known that when two wheels act in each other, the one which has most teeth makes the one which has the fewest teeth go round as many times as the number of teeth in the small wheel is contained in the number of teeth in the large wheel.

Thus, for instance, taking a wheel of 48 teeth and a pinion of 6, the pinion will make 8 turns while the large wheel makes 1 turn.

The ratio of the number of turns between the two arbors is therefore represented by the expression $\frac{48}{6} = 8$.

Now, if we suppose the time is known which the pinion of 6 takes to go once round, it is evident that the wheel of 48 teeth, which has 8 times the number of teeth, will take 8 times as long to go round once.

The ratio of the times is therefore represented by the expression $\frac{48}{6} = 8$. Only in the first case the ratio is inverse,* and in the second, it is direct.†

This theorem is easily understood in the simple case of two wheels; and it is known to be equally true for a train of any number of wheels; that is to say, that the revolutions of the first and last arbors are exactly in the same ratio as if there were only two wheels in motion; the one of which should be the product of the number of teeth of all the driving wheels, and the other the product of the number of teeth in all the wheels driven.

Thus, in a train of three arbors, arranged as follows, viz:

* The ratio is inverse, because the greater number applies to the wheel in motion making the lesser number of revolutions.

† The ratio is direct, because the greater number applies to the wheel in motion, which takes the longer time to make one turn.

A first wheel of 53 teeth, driving a pinion of 8; upon this pinion is rivetted a wheel of 41 teeth driving an ultimate pinion of 7. In this train the drivers are the wheels of 53 and 41, and those driven are the pinions of 8 and 7. Now, according to the principle set forth above, the ratio of the velocities of the wheel of 53 and the pinion of 7 is represented by the expression $\frac{53 \times 41}{8 \times 7} = \frac{2173}{56} = 38{\cdot}80357$ nearly.

The quotient 38·80357 expresses very nearly the number of turns of the pinion of 7 for one turn of the wheel of 53.

We see here that it is always easy when the train is given, to determine the ratio of the velocities between the two arbors; for, after having found the product of the numbers of teeth of all the drivers, and the product of the numbers of teeth in all driven, we must divide these two one by the other.

This principle being well understood, let us now pass to the calculation of the numbers of teeth which should be given to the wheels of a train, so that the velocities of their arbors may be in a given ratio, or nearly so.

We have seen that the ratio indicated under the form of a vulgar fraction is the exact ratio; while the quotient expressed as a decimal, is often nothing more than an approximation. Although in both cases the operations to be performed are the same, yet it would be preferable to make use of the exact ratio; that is to say, of the one expressed in vulgar fractions.

Problem I.

An arbor turns in 23 minutes, we require a train that will drive another arbor round in 3 hours 11 minutes, that is to say 191 minutes.

Here, the ratio of the velocities of the two arbors is expressed by the fraction $\frac{191}{23}$

On examining these figures, we perceive that they are both prime numbers, and consequently to produce the revolution required, we must employ a pinion of 23 and a wheel of 191 teeth; but if the general conditions of the piece of clock-work do not permit the employment of a wheel whose circumference would bear so great a number of teeth, it is evident that we must be content with an approximation.

Then the problem comes to this: instead of the ratio $\frac{191}{23}$ to substitute another ratio expressed in smaller terms, and containing the least error possible.

Among the known means of resolving a question of this nature, the most expeditious proceeding is, without doubt, that of continuous fractions; they alone possessing the property of giving the lowest numbers and the nearest approximate; but, on the other hand, the employment of this process is not within the reach of most practical men, and its resources are so limited that the results must often be abandoned to go in search of other numbers by chance.

The method which I propose enables us to find a greater number of results; the operations are very simple and within the reach of all.

Let us return to the ratio $\frac{191}{23}$ and calculate by this method all its approximate expressions in smaller numbers.

It is evident that in each of these expressions the number expressing the pinion ought to be contained in the number expressing the wheel, so many times as 23 is contained in 191, or nearly so.

By dividing therefore 191 by 23, we have 8 for quotient with a remainder; then we see that the given ratio falls between the ratio of 8 to 1 and the ratio of 9 to 1.

If we give the wheel 8 times as many teeth as the pinion, it will make but 1 turn for 8 turns of the pinion, that is to say, in 8 times 23 = 184 minutes: the error (minus) which results from employing the ratio of 8 to 1 is therefore equal to 191 minus 184 = 7 minutes.

By using a wheel with 9 times the number of teeth in the pinion, the wheel will take 9 times longer than the pinion to make 1 turn, that is to say, 9 times 23 = 207 minutes.

Then with the ratio 9 to 1, the error (plus) is equal to 207 minus 191, or 16 minutes.

Let us observe, by the way, that the division of 191 by 23 gives 8 for a quotient with a remainder of 7; so that the true quotient is $8 + \frac{7}{23}$, or it may be written $9 - \frac{16}{23}$.

This last fraction is the compliment of the first.

Therefore the errors in minutes are represented by the numerators 7 and 16.

Let us place the numerator 7 opposite to the ratio of 8 to 1. Let us also place the numerator 16 opposite to the ratio of 9 to 1, and construct the following table, in which, the numbers in the first column represent the wheels, those in the second are the pinions, and those in the third will serve to calculate the intermediate ratios.

	8	:	1	−	7
(1.)	. . .		. . .		. . .
	. . .		. . .		. . .
	9	:	1	+	16

Subtract 7 from 16, and 9 remains. Let us write this difference over the 16, and opposite to it, place the ratio of 17 to 2, which results from adding, term for term, the ratios of 8 to 1 and 9 to 1; and our table will stand thus:

	8	:	1	−	7
(2.)	. . .		. . .		. . .
	17	:	2	+	9
	9	:	1	+	16

Let us operate upon the ratio of 8 to 1 and the new ratio of 17 to 2, as we did upon the two first, that is to say, subtract 7 from 9, there remains 2; let us write this difference over the 9, and opposite to it let us place the ratio of 25 to 3, which is the result of adding, term for term, the ratios 8 to 1 and 17 to 2, our Table will then be:

	8	:	1	−	7
	. . .		. . .		. . .
(3.)	25	:	3	+	2
	17	:	2	+	9
	9	:	1	+	16

Here, the remainder 2 being smaller than 7 we first subtract it from 7, and, successively, from the remainders; and under the number 7 we place these successive remainders. Finally, adding, term for term (as before) the ratios that are standing opposite, we obtain the following Tables:

(4.)

8	:	1	−	7
33	:	4	−	5
...	:	...		...
...	:	...		...
...	:	...		...
25	:	3	+	2
17	:	2	+	9
9	:	1	+	16

(5.)

8	:	1	−	7
33	:	4	−	5
58	:	7	−	3
...	:	...		...
...	:	...		...
25	:	3	+	2
17	:	2	+	9
9	:	1	+	16

(6.)

8	:	1	−	7
33	:	4	−	5
58	:	7	−	3
83	:	10	−	1
...	:	...		...
25	:	3	+	2
17	:	2	+	9
7	:	1	+	16

These six Tables are only given to make the process of the calculation intelligible; but we shall see presently that we could have obtained the last by a direct process.

Working for the last, as we did for those before it, we obtain the complete Table, following, in which the ratios that approximate to the given ratio are arranged in order of their value.

	8	:	1	—	7
	33	:	4	—	5
	58	:	7	—	3
	83	:	10	—	1
(7.)	191	:	23		0
	108	:	13	+	1
	25	:	3	+	2
	17	:	2	+	9
	9	:	1	+	16

In these results we again find the given ratio of $\frac{191}{23}$; the ratios above it give a minus error, and those below a plus error.

Let us take some of these ratios and calculate the errors which they contain.

Let it be the ratio of 58 to 7, that is to say, take a wheel of 58 and a pinion of 7; as the pinion turns in 23 minutes, we can find the time which a wheel of 58 takes to make its revolution, by working out the following proportion,

$$\text{As 7 is to 23 so is 58 to } \frac{23 \times 58}{7}$$

This last term is equal to $\frac{1334}{7}$ or $190^{\text{m}} + \frac{4}{7}$

But from the conditions of the problem, this wheel ought to turn in 191 minutes: therefore the error (minus) is equal to $\frac{3}{7}$ of a minute.

By using the ratio of 25 to 3 the degree of approximation will be found by the proportion,

$$\text{As 3 is to 23 so is 25 to } \frac{23 \times 25}{3} = \frac{575}{3} = 191^{\text{m}} + \frac{2}{3}.$$

We may observe, that the error is represented by a fraction of a minute, having for its numerator the number in the third column, and for its denominator the number in the second column; and therefore we might dispense with the calculation.

Again, taking a pinion of 10 and wheel of 83 teeth, the error in the time of the revolution of the latter will be $\frac{1}{10}$ of a minute.

Lastly, taking a pinion of thirteen and a wheel of 108 teeth, the error will be only $\frac{1}{13}$ of a minute; and in the case in question

this is the closest degree of approximation that can be attained by employing two wheels and pinions.

If we want a greater degree of accuracy we must have a train with three arbors, carrying two wheels and two pinions; that is to say, to make use of a ratio each of whose terms admits of two suitable factors.

Taking, then, from the list of ratios found the exact ratio $\frac{191}{23}$ and one of the ratios $\frac{83}{10}$ and $\frac{108}{13}$ which contain the smallest errors, we calculate the intermediate quantities by pursuing exactly the course pointed out for the formation of the preceding tables.

We shall then have two series of results; those in the first will contain an error minus and those in the second an error plus; but this error will go on continually diminishing, accordingly as we employ higher numbers.

Here are the two series,—

(8.)

	83	:	10	—	1
	274	:	33	—	1
(*a*)	465	:	56	—	1
	656	:	79	—	1
(*b*)	847	:	102	—	1
	1038	:	125	—	1
	1229	:	148	—	1
(*c*)	1420	:	171	—	1
	1611	:	194	—	1
(*d*)	1802	:	217	—	1
	1993	:	240	—	1
	.....	:	....		
	.....	:	....		
	.....	:	....		
	.....	:	....		
	191	:	23	—	0

(9.)

	108	:	13	+	1
(*e*)	299	:	36	+	1
	490	:	59	+	1
	681	:	82	+	1
(*f*)	872	:	105	+	1
	1063	:	128	+	1
	1254	:	151	+	1
(*g*)	1445	:	174	+	1
	1636	:	197	+	1
(*h*)	1827	:	220	+	1
	2018	:	243	+	1
	.....	:	....		
	.....	:	....		
	.....	:	....		
	.....	:	....		
	191	:	23	+	0

In these two tables, each of the numbers in the first column representing the product of the wheels, and each in the second coloumn shewing the product of the pinions, we can only avail ourselves of the ratios where the greatest prime factor of each of the terms can be applied, the one to a wheel and the other to a pinion.

We can easily find these factors by making use of a Table of Divisors, that of Burkardt, for example, which is the most accurate, and which gives the smallest factors, in prime numbers, of all numbers as high as three millions.

Trains deduced from Table 8.

(*a*)	$\frac{465}{56}$	=	$\frac{\text{wheels}}{\text{pinions}}$	$\frac{5.\ 93}{7.\ 8}$
(*b*)	$\frac{847}{102}$	=	$\frac{\text{wheels}}{\text{pinions}}$	$\frac{11.\ 77}{6.\ 17}$
(*c*)	$\frac{1420}{171}$	=	$\frac{\text{wheels}}{\text{pinions}}$	$\frac{20.\ 71}{9.\ 19}$
(*d*)	$\frac{1802}{217}$	=	$\frac{\text{wheels}}{\text{pinions}}$	$\frac{34.\ 53}{7.\ 31}$

Trains deduced from Table 9.

(*e*)	$\frac{299}{36}$	=	$\frac{\text{wheels}}{\text{pinions}}$	$\frac{13.\ 23}{6.\ 6}$
(*f*)	$\frac{872}{105}$	=	$\frac{\text{wheels}}{\text{pinions}}$	$\frac{8.\ 109}{3.\ 35}$
(*g*)	$\frac{1445}{174}$	=	$\frac{\text{wheels}}{\text{pinions}}$	$\frac{17.\ 85}{6.\ 29}$
(*h*)	$\frac{1827}{220}$	=	$\frac{\text{wheels}}{\text{pinions}}$	$\frac{29.\ 43}{11.\ 20}$

If, among the ratios that have been discovered, there should not be one that can be made available, we could still find other intermediate ratios by adding, term for term, two consecutive ratios; but in this case, the approximation will not be in the ratio of the magnitude of the numbers employed, and the error that results from employing these intermediate ratios will be represented by a fraction having for its numerator the sum of the numbers in the third column, and for its denominator, the sum of the numbers in the second column.

Example.

$$\frac{465+656}{56+79} = \frac{1121}{135} = \frac{\text{wheels}}{\text{pinions}}\ \frac{19.\quad 59}{5.\quad 27}$$

$$\text{error}\ \frac{1+1}{56+79} = \frac{2}{135}$$

We have solved the problem by availing ourselves of the ratio expressed by the vulgar fraction $\frac{191}{23}$; we could have solved it if nothing had been given but the

quotient of these two numbers, that is to say 8.30435.

Then the problem would have stood thus:

Required a train such that one turn of the first arbor may cause the last axle to turn 8.30435.

The ratio of the number of teeth in the wheel to the number of leaves in the pinion falls between the ratio of 8 to 1 and that of 9 to 1.

The first contains an error equal to —0.30435.
The second.................... + 0.69565.

The last decimal fraction is the complement of the first.

We then work as before, placing the number 0.30435 opposite to the ratio of 8 to 1, and also the number 0.69565 opposite to the ratio of 9 to 1, as in the following table,

$$\begin{array}{lcr} 8 : 1 & & -\ 0.30435 \\ \cdots\cdots & \cdots\cdots & \cdots\cdots \\ \cdots\cdots & \cdots\cdots & \cdots\cdots \\ 9 : 1 & & +\ 0.69565 \end{array}$$

We then calculate the intermediate quantities by subtracting, successively, the numbers in the third columns, and also adding in succession, term for term, the numbers in the first and second columns, term by term; we shall then have a table exactly similar to that calculated by means of the vulgar fraction (see Table 7.)

I have now to speak of the table for the conversion of decimals into vulgar fractions.

This table contains all vulgar fractions whose denominators are less than 100.

They are arranged in the order of their values, and opposite to each is its expression calculated to the tenth decimal place.

I shall now show how by the aid of this table we may easily find any number required.

Let us take the ratio 8.30435.

From the table we find that this is equivalent to $\frac{7}{23}$.

For the ratio of 1 to 8.30435 we may therefore substitute that of 1 to $8 + \frac{7}{23}$ or 23 to 191; but we have seen that these numbers cannot be made available, because 191 is a prime number and is too high for a wheel.

Then let us take from the table the two fractions between which the fraction $\frac{7}{23}$ is placed. These fractions are $\frac{2}{79}$ and $\frac{25}{82}$, we shall then have the two ratios following:—

$$1 : 8 + \frac{24}{79} \text{ or } 79 : 656$$

$$\text{and } 1 : 8 + \frac{25}{82} \text{ or } 82 : 681$$

The first contains an error minus; and if we combine it with the ratio 23 to 191, by means of successive additions, we shall find the same results as those in Table 8.

The second contains an error plus; and its combination with the ratio 23 to 191 will give the same results as those in Table 9.

Again, let us employ the table of fractions to solve the following problem.

PROBLEM II.

An arbor turns in 24 hours, or 1 day; required a train that will give another arbor one turn in 87 days ·96926 which is the time of the revolution of the planet Mercury.

In the table we do not find the decimal fraction 0·96926, but the two consecutive fractions that are nearest are $\frac{63}{65}$ and $\frac{95}{98}$

The first is too low, and the other is too high.

Substituting successively for the given decimal fraction these two vulgar fractions, we shall have the ratios following,

$$87 + \frac{63}{65} : 1, \text{ which gives } 5718 : 65$$

$$87 + \frac{95}{98} : 1, \text{ which gives } 8621 : 98$$

Adding these ratios, term for term, we shall have 14339 to 163 for an intermediate ratio, as is seen in the following table

$$\begin{array}{rcl} 5718 & : & 65 \\ 14339 & : & 163 \\ 8621 & : & 98 \end{array}$$

Adding, term for term, two of the consecutive results of the above table, we shall have two new intermediate ratios, and the table will stand thus,

$$\begin{array}{rcl} 5718 & : & 65 \\ 20057 & : & 228 \\ 14339 & : & 163 \\ 22960 & : & 261 \\ 8621 & : & 98 \end{array}$$

In these five results, one alone can furnish a train, it is,

$$\frac{22960}{261} = \frac{\text{whl. } 112. \ 205}{\text{pin. } 9. \ 29} = \frac{\text{whl. } 10. \ 56. \ 41}{\text{pin. } 3. \ 3. \ 29}$$

Dividing 22960 by 261 to find the degree of approximation obtained by these numbers, we have .... 87·96935
And the error is equal to .... + 0.00009

I confine myself to these two examples.

This rapid sketch of the method which I propose seems sufficient to shew its utility, but I do not think that we ought to over-

look certain developements, in order to apply the method to all cases that may occur.

Awaiting the time when I may send my work to the printer, I offer my services to such of my fellow-workmen as have need to calculate a train, either to give them the necessary information or to perform the calculation. ACHILLE BROCOT.

NOTES ON CHRONOMETERS.

To the Editor of the Horological Journal.

SIR,—It may not be useless to offer a few directions and suggestions as to the mode of placing chronometers on board a ship, and as to the care that should be bestowed upon them.

1. The error, if not the rate, of a chronometer may be altered by moving the instrument from the shore to a ship. The error and rate, therefore, obtained on shore should not be implicitly relied upon, especially when opportunities are afforded of checking them, before losing sight of land. An observation of a "time ball," when one is visible, or sights taken to determine the time, when the latitude and longitude of the ship can be well ascertained by bearings of some well-known object on shore, whose latitude and longitude may be given in the tables of positions, should be taken whenever possible. The error obtained by either of these methods will shew, should the chronometer have been two or three days on board, whether or not the shore error has changed. Two or more such observations, if obtainable, would serve to check the rate.

2. All possible opportunities should be taken to check the error of a chronometer, both by lunar observations and by the comparison of the ship's position, found in the usual way, with that found by compass bearings when sighting a headland, islet, or rock, whose position has been well determined; and also by comparisons with the time on arrival in port.

3. The chronometer should be kept in one place and secured in one position, with the twelve-hour mark in one constant direction with the ship's length.

Some chronometer raters affirm, that an instrument may have a different rate according as the twelve-hour mark points in the N., S., E., or W. direction, although the dial be horizontal. Some persons also attribute the deviation of the rate to the magnetical influence of the ship upon the steel in the balance and spring; and, although nothing certain has been deduced as to the amount of this effect, it is not at all an improbable source of error. Under these circumstances, therefore, the best plan is to keep the chronometer in the same relative position with regard to the ship.

It is not advisable to keep a chronometer in a drawer, or on a shelf attached to a bulkhead. A very good plan is to have a block of wood about two feet high, fastened by bolts or otherwise firmly to the deck of the cabin, over a beam, and as near the centre of rolling motion as possible. On the top of this block, an open box should be screwed, sufficiently large to receive the chronometer and allow about two inches space all round. A layer of about two inches of coarse sawdust should be put in the box, upon which the chronometer (as it is slung in its gimbuls in its own box) should be placed, and secured by a packing of sawdust round the sides, so that it could not be displaced unless the ship were upset. The sides of the box should not be too high; but sufficiently high to allow the chronometer box to open conveniently, to take the time. Instead of sawdust, a cushion of hair or wool is suitable, but not preferable. On the same plan, one box could be made and partitioned off for several chronometers. Admiral Fitzroy recommends a similar plan, and observes of those fitted on board H.M.S. Beagle,—"Placed in this manner, neither the running of men upon deck, nor firing of guns, nor running out of chain cables causes the slightest vibration in the chronometers, as I often proved by scattering powder upon their glasses and watching it with a magnifying glass, while the vessel herself was vibrating to some jar or shock... ...The ordinary motions of a ship, such as pitching and rolling moderately, do not affect tolerably good time-keepers, which are fixed in one place, and defended from vibration as well as concussion."—*Appendix to the Narrative of the Voyage of the Adventure and Beagle.*

4. On no account should a chronometer be moved from its place during a voyage.

For taking time on deck, or even on shore, when observing with an artificial horizon, or when in a foreign port, a captain desires to obtain the error of his chronometer, either from parties on shore or a man-of-war, a good pocket watch with a second-hand should be employed, care being taken to compare it with the chronometer both before and after making the observations.

5. The same person should wind and compare the chronometers, for the sake of uniformity of method and punctuality.

They are generally constructed to go for two days, but they should never be allowed to do so; winding should be performed regularly at the same hour daily. Some instruments are constructed to go for eight days. These are not satisfactory, generally, in their performance, and should not be preferred; they should be wound up regularly once a week, about the same hour and day. Some persons make so many turns only, and then finish. Time-keepers should be wound to the full extent, but toward the end the operation should be performed so as to feel the stop gently.

6. A thermometer should be placed with the chronometer and carefully registered.

If the rate on shore has been given for different temperatures, which it should be, —at least for 40°, 60°, and 80°,—the navigator should apply the rate accordingly, and should carry on the error daily, in a book for the purpose. This book should be ruled for (1) the date, (2) the temperature, (3) the rate allowed, (4) the error, brought on for the date, and (5) a remark column in which notice should be taken of all checks made upon the time, error, and rate.

If this were done, with the care that it should be, such incidents as two first-class ships meeting in the Indian Ocean near the equator, and differing in their longitude by 90 miles, would be less likely to occur. Such discrepancies are of common occurrence, and happen probably from the same rate being used throughout a voyage; the rate having been found in a certain temperature, while the ship has been in temperatures much higher or lower.

7. Once at least in every three years, the chronometer should be examined by a skilful maker, and, if necessary, cleaned and oiled, as the constant friction and wear of the pivots causes the oil to thicken, and hence to retard the movements.

8. In iron ships, or vessels having much iron in their build or cargo, chronometers may be affected by magnetic action, particularly if the ship's head has been long in one direction. Lightning striking a ship has been repeatedly known to affect the compass; it may also affect the chronometers. On these matters, careful navigators, who pay all due attention to their scientific instruments, may be able to establish facts from which alone inferences can be deduced.

Much of the above has been gleaned from the publications of Admiral Fitzroy; by bringing it together here I hope it will be interesting to your readers.

In conclusion, I may be allowed to suggest, that the Admiral's "Notes on Meteorology," and "Barometer Guide," and "Manual," pamphlets recently published, are well worth the perusal of the members of the B.H.I., especially those who are engaged in the sale or manufacture of meteorological instruments. The Admiral has suggested a new scale for barometers, which is being much discussed just now; and many remarks and suggestions upon the improvements of instruments are to be found in these little books.

I am, Sir, respectfully your's,

R. Strachan.

7, Arthur Street, Gray's Inn Road, W. C.
15th *September*, 1860.

ON THE EXPANSION OF WOOD BY HEAT.

By David Rittenhouse LL. D.

President of the American Philosophical Society.

It is well known that bodies in general enlarge their dimensions, or expand, on being heated, and contract in cooling. From some experiments heretofore made, wood has been thought to make an exception to the general rule, and this opinion has so prevailed that many curious persons have applied wooden pendulum rods to their time-pieces, to prevent the variation in their rate of going, arising from the expansion and contracting of a metal rod. From my own observations, however, as well as those of some of my friends, the wooden pendulum rod does not appear to answer the expectations formed on it. I had in my possession for several years an excellent time-piece made for this society by an ingenious workman and worthy member of the society. The result of my constant attention to this clock was, that though its regular variations with heat and cold were probably much less than those of metal pendulums, it nevertheless went always faster in winter than in summer, and was liable to very sudden and considerable variations; arising, no doubt, from the combined effects of heat and cold, moisture and dryness. This determined me to make some careful experiments with a pyrometer capable of receiving a piece of wood of the length of a second pendulum. Several years ago I made some experiments of this kind, perfectly corresponding with those I have lately made, and which I now communicate to the society.

I took a straight-grained piece of white hiccory, green, for I could not procure any seasoned, its length 30 inches, and about ¼ of an inch square. This I placed in my pyrometer, and kept it fully extended by a

weight fastened to a string, going over a pulley. To the pyrometer I applied the tube and glasses of a good compound microscope, and a micrometer, the value of the smaller divisions whereof I found to be nearly ·00053 parts of an inch each.

The rod of wood being placed in the pyrometer, I poured sand all around it, heated to about 250 of Fahrenheit, which degree of heat I found the wood would bear without scorching. On pouring in the hot sand, the rod expanded very much, but soon began to contract, even before the sand was sensibly cooled, which I suppose arose from the hot sand extracting the moisture of the wood. It continued to contract as the whole grew cool, so that when the rod had acquired its first temperature it was near 30 of the above divisions shorter than at first. I repeated the operation a second and third time, and had then reason to conclude that the wood was nearly as dry as it would become by lying long in a dry air. I now let it cool to the temperature of the atmosphere which was 75°, and heating the sand to 200 only I poured it around the rod. In a few minutes it expanded 16 divisions. In half an hour the sand had cooled to 125, and the rod had contracted 11 divisions. In an hour more the sand was 80, and the rod shortened full 4 divisons more, being nearly equal to its length when the sand was first applied. On the whole I conclude that very dry wood expands with heat pretty regularly, though certainly in a much less degree than any of the metals or even glass.

The rod above-mentioned having been kept in a dry place for twelve months, I again tried it with the pyrometer, having fixed near one end of it a small graduated scale of ivory, 360 divisions whereof were equal to one inch. This scale was viewed with the microscope, furnished with a cross hair, and I thought this method preferable to the screw micrometer used before.

The rod was placed in the pyrometer when the temperature of the air was about 60°. On pouring sand around it, heated a little higher than boiling water perhaps, it immediately expanded ½ a division, but in less than a minute it began to contract, and continued to do so for an hour, when I drew off the sand. It was now full 10 divisions shorter than at first, so that it had imbibed a great deal of moisture from the air which it again parted with to the heated sand. Three hours afterwards, when the rod was cool, I again poured the sand on it, heated as before. It now continued to expand for about three minutes, when its length was increased 3½ divisions, it then began to contract, and became full 3 divisions shorter than when the sand was poured on it. I caused the sand to run off once more, and let the rod cool. Then heating the sand 250° by a thermometer, I poured it on the rod, and in a few minutes expanded 3¾ divisions, it then began to contract slowly, and in 15 minutes it became ¾ of a division shorter than at first. On the whole, I concluded that the expansion of wood, in its length, will be irregular, corresponding partly to the warmth, and partly to the moisture of the atmosphere.

COMPENSATION BALANCES.

To the Editor of the Horological Journal.

Sir,—I have read a great deal about Balances in your valuable Journal, and shall be glad to have your opinion, and also the opinion of those gentlemen who have written therein,—the reason compensation balances are cut open at the side of the arm, instead of being cut open in the centre of the rim, as was once the fashion of the old makers.

In No. 19 of your Journal (*plate I., fig.* 4), is a representation of a balance composed of two semi-circles, each formed of a piece of brass and steel, and united as in Mr. Harrison's thermometer piece. This is from the description of Le Roy's Prize Chronometer: the balance rim is cut open in the centre. The question now is: Is not this the best method of cutting open compensation balances for marine chronometers?—would the middle error temperature be as great with balances thus cut open, as it now is with their being cut open at the side of the arm? Any opinion which may be given by you or your readers, will oblige yours, &c.

ENQUIRER.

MAGICAL CLOCK.—Droz, a Genevian mechanic, once constructed a clock which was capable of the following surprizing movements: there were seen on it a negro, a dog, and a shepherd; when the clock struck, the shepherd played six times on his flute, and the dog approached and fawned upon him. This clock was exhibited to the king of Spain, who was delighted with it. "The gentleness of my dog," said Droz, "is his least merit; if your Majesty touch one of the apples which you see in the shepherd's basket, you will admire the fidelity of the animal." The king took an apple, and the dog flew at his hand, and barked so loud, that the king's dog which was in the room began also to bark. At this the courtiers, not doubting that it was an affair of witchcraft, hastily left the room, crossing themselves as they went out; the minister of marine was the only one that ventured to stay. The king having desired him to ask the negro what o'clock it was, the minister obeyed, but he obtained no reply. Droz then observed, that "the negro had not yet learned Spanish."

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electro-metallurgic process" to the depositing of a thin film of gold or other metal incorrodible by the atmosphere, upon the steel balance spring and compensation balance spring and compensation balance, whereby rust is prevented.

[Printed, 9*d*. See Repertory of Arts, vol. 15 (*new series*), p. 280; Mechanic's Magazine, vol 34, p. 249; and Inventors' Advocate, vol. 4. p. 180.]

1840, September 24.—No. 8645.

JOHNSTON, John.—The nature of the invention consists in the application of a suspended weight to the balance, so that this weight, by means of locomotion, may increase the number of the vibrations of the balance, and thus determine the space passed through by any locomotive body. Thus the effect of the weight on the timepiece, in consequence of the resistance of any body to motion, will be that, by two seconds being gained for one mile in respect to proper time, four will be gained in two miles, and so on. Of course, a watch for proper time alone must also be used.

[Printed, 5*d*. See Mechanics' Magazine, vol. 34, p. 287; and Inventors' Advocate, vol. 4, p. 212]

1841, January 11.—No. 8783.

BARWISE, John, and BAIN, Alexander.—1. The application of the vibration of a pendulum to make and break alternately an electric circuit, so that an electric current may be transmitted as the moving power to clocks,—the attractive power produced in soft iron by an electric current being used for this purpose.

2. The application of an electric current in connection with a pendulum, to any number of clocks in succession, each clock being connected with a separate conducting wire. The application may also be to the clocks at the same instant.

3. The application of an electric current in connection with a pendulum, to wind up and keep going any number of clocks; to set in succession the hands of any number of electro-magnetic clocks; and to set the hands of an ordinary timepiece.

4. The application of conducting wires insulated in any of the usual ways, and twisted together so as to form a rope, for the purpose of transmitting electric currents as the moving power in clocks.

5. The application of electro-magnetism in lieu of springs and weights in ordinary pendulum-clocks.

6. The application of the vibrations of the balance in connection with the balance spring, to make and break the electric circuit at proper intervals, so that electric currents may be transmitted as a moving power to clocks and timepieces.

7. The application of an electric current to the striking of a clock.

8. The transmission, through a series of clocks, of an electric current.

[Printed, 2*s* 8*d*. See Mechanics' Magazine, vol. 35, p. 139; and vol. 39, pp. 65 and 97; and Inventors' Advocate, vol. 5, p. 71.]

1841, May 4 —No. 8947.

MASSEY, Francis Joseph. — The invention is for winding up watches by means of a pendant. Every push of the pendant acts upon the rack and moves four teeth of the ratchet on the going barrel. The pendant is returned to its place after every push by a circular spring. The patentee particularly claims;—

1. "Keeping the rack in action by means of a " spring, with a stud fastened in the rack, acting in " a parallel slo ."

2. " Using the stud in the rack, with a screw to " adjust the length of the pendant."

3. " Using a round pendant push-piece, with a sliding stop," and also " making the pendant with " a push-piece four-square, or of such other form as " to dispense with the necessity of any fittings in the " groove or middle part of the case, at the same time " allowing the pendant not to go close down to the " edge of the case"

4. The use of " a circular spring, acting at its point " on an inclined plane or arm of the rack, thus " obtaining increased length of spring, and doing " away with the risk of breaking."

[Printed, 5*d*. See Mechanics' Magazine, vol. 35, p. 398; and Inventors' Advocate, vol. 5, p. 309.]

1841, June 23.—No. 8997.

WALKER, William, the elder. — An improved form of escapement, consisting in making the teeth of the escape wheel of such a shape that the recesses between them form portions of circles; the ends or tops of the teeth being of an angular shape, lowest at the side where the teeth first touches the lever, and inclining upwards at an angle of about twenty-five degrees. These angular teeth act upon round pins moveable on an axis fixed upon the lever. By this invention, the friction is lessened and banking pins done away with.

[Printed, 5*d*.]

1841, October 14.—No. 9120.

MASSEY, Edward.—1. Attaching compensation to the pendulum spring. The patentee uses a curb (acting on pivots placed over but not in connection with the verge) which is moved backwards and forwards on the pendulum spring by means of a small chain, one end of which passes round a pulley formed on the curb, the other end being attached to a lever acted upon by the compensation piece; the curb pulley has a spiral spring attached to keep the said chain on the stretch. Another method is by having a straight spring connected with the pendulum spring by means of a curb; the spring is lengthened and shortened by a clamp sliding in the frame; the clamp has a small chain fastened at each end; one chain connecting it with the lever acted upon by the compensation piece, the other with a lever which is acted upon by a spiral spring so as to keep the two chains always on the stretch, thereby causing a steady and certain action of the clamp up and down the grooves of the frame.

2. Relates to the arrangement of the locking pallets.

3. Winding up watches by means of the pendant. The pendant is connected to a plate which is capable of sliding in a dovetail groove in the pillar plate. This plate carries a catch which takes into the ratchet wheel fixed on the barrel arbor. The watch is wound by drawing out and pressing in the pendant, a click preventing the mainspring running down.

4. The action of the alarm part is by means of a small wheel with twelve teeth fixed on the upper part of the seconds' wheel. The hammer has a tail acted upon by this wheel, so that every tooth of the small wheel lifts the hammer, and therefore makes it strike every fifth second.

[Printed, 6*d*.]

1842, March 21.—No. 9302.

DENT, Edward John. — 1. Applying to the ordinary compensation piece, which the patentee calls the "primary compensation," a secondary compensation piece, "in all forms and positions," which shall augment or diminish the distance between the centre of gravity of the compensation weights, and the junction of the primary compensation piece with the bar.

2. Applying secondary compensation pieces, erected upon the ends of a diameter compensation bar, whereby the weights are raised by means of heat from their point of junction with the ends of the compensation bar, in which a curvature upwards takes place; the weights, being raised, are taken by the curvature quicker, and over a greater space of motion. On a decrease of temperature the reverse takes place.

3. The introduction of a second or "train" escape wheel, which revolves concentrically with the "impulse" escape wheel. The mode of unlocking the escapement is the same as in the ordinary detached escapement, save that the two escape wheels are simultaneously unlocked by the same spring at each vibration. The result is that a constant impulse is given to the balance by the impulse escape wheel, without its receiving any lateral pressure beyond the pressure of the connecting remontoire spring.

[Printed, 8*d*. See Repertory of Arts, vol. 2 (*enlarged series*), p. 358; and Record of Patent Inventions, vol. 1, p. 145.]

1842, August 8.—No. 9438.

PERRIN, Charles Henri.—Improvements in time-pieces to prevent over-winding, and to prevent any harm arising from the key being turned the wrong way. The essential point in this invention is, that the central axis to which the winding-up key is applied is not fastened into the fusee or into the axis of the spring barrel, but is fitted into the fusee or into a central perforation through the axis of the spring barrel, with liberty to turn freely round, except as prevented by a toothed ratchet which is fastened on the said central axis, and by a detent which acts in the teeth of this ratchet; the centre of motion of which detent is borne by the fusee or by a piece affixed to the perforated axis of the spring barrel; and which detent will, by the action of a suitable spring, hold in the teeth of the ratchet when the key is turned the proper way, but will allow them to slip easily if turned the wrong way. The patentee makes the detent, in various ways, become wholly disengaged from the teeth of the ratchet, when the spring is wound up as far as it should be; and in consequence the key and the central axis to which it is applied, will be set at liberty to turn freely round.

[Printed, 1*s*. 4*d*.]

EQUATION OF TIME TABLE

For December 1860.

Day of the Week	Day of Mnth	At Apparent Noon — Equation of Time to be *subtracted* from Apparent Time.	Difference for One Hour.	At Mean Noon — Equation of Time to be *added* to Mean Time.
		m. s.	s.	m. s.
Sat. ..	1	10 35·64	0·966	10 35·47
Sun. ..	2	10 12·46	0·993	10 12·29
Mon ..	3	9 48·64	1·018	9 48·47
Tues ..	4	9 24·21	1·042	9 24·05
Wed ..	5	8 59·21	1·065	8 59·05
Thurs.	6	8 33·65	1·087	8 33·49
Fri. ..	7	8 7·56	1·108	8 7·41
Sat. ..	8	7 40·98	1·128	7 40·84
Sun ..	9	7 13·92	1·146	7 13·78
Mon ..	10	6 46·41	1·163	6 46·28
Tues ..	11	6 18·50	1·178	6 18·38
Wed. ..	12	5 50·24	1·192	5 50·12
Thurs..	13	5 21·63	1·205	5 21·52
Fri. ..	14	4 52·72	1·216	4 52·62
Sat. ..	15	4 23·54	1·225	4 23·45
Sun. ..	16	3 54·14	1·233	3 54·06
Mon ..	17	3 24·56	1·239	3 24·49
Tues ..	18	2 54·83	1·244	2 54·77
Wed ..	19	2 24·98	1·247	2 24·93
Thurs..	20	1 55·05	1·249	1 55·01
Fri. ..	21	1 25·07	1·250	1 25·04
Sat. ..	22	0 55·08	1·249	0 55·06
Sun. ..	23	0 25·13	1·246	0 25·12
		added to		*subtracted from*
Mon...	24	0 4·77	1·243	0 4·77
Tues ..	25	0 34·59	1·238	0 34·58
Wed ..	26	1 4·29	1·232	1 4·27
Thurs..	27	1 33·86	1·225	1 33·82
Fri. ..	28	2 3·25	1·216	2 3·21
Sat. ..	29	2 32·43	1·206	2 32·36
Sun. ..	30	3 1·38	1·195	3 1·32
Mon ..	31	3 30·07	1·183	3 30·00

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BRITISH HOROLOGICAL INSTITUTE.

DISCUSSION ON THE LEVER ESCAPEMENT.

The Council have to announce, that a DISCUSSION will take place at the Institute, on Tuesday the 8th instant, at Eight P. M., on the subject of the Paper read by MR. JAS. F. COLE, V. P., a Report of which appears in the present number of the Journal.

The Council regret to inform the Members, that Mr. C. MILL FRODSHAM was unexpectedly prevented from giving his Reading on the 11th ult.

CLASSES FOR INSTRUCTION IN GEOMETRY AND DRAWING.—The Council invite the attention of the Members, to the most gratifying Report of the progress made by the Pupils in the above Classes, which induced the Council to award them an additional number of Prizes. The THIRD QUARTER has just commenced, and at the termination of the following Quarter, in May, the Council will again award Prizes to the most proficient Pupils.

A few more names can be received, and further particulars obtained, on application to GEORGE E. MYLNE, *Honorary Secretary*.

BY ORDER.

THE HALF-YEARLY GENERAL MEETING.

The Half-yearly Meeting of the Members was held at the Offices of the Institute, 35, Northampton-square, on Friday, 21st December, Mr. COLE, one of the Vice-presidents, was in the chair.

The Honorary Secretary, Mr. G. E. MYLNE, read the following Report and Balance-sheet:—

REPORT OF THE COUNCIL FOR THE HALF-YEAR ENDING 15TH DECEMBER, 1860.

"The Council have to place before you the report for the past half-year, an audited financial statement, which is of a gratifying character, showing that the Institute still continues to make great progress.

"The present number of members amount, to 358 annual and half-yearly members, of whom 59 are also founders and donors, 21 are life members, and 10 are junior members. 39 annual and half-yearly and 3 junior members have joined since the last meeting in June.

The Horological Journal has made satisfactory advancement during the past six months, with a largely increased sale, for which the Council have to express their cordial thanks to the Journal Committee and their much-valued contributors.

"A Reading was kindly given by Mr. Jas. F. Cole, one of the Vice-presidents of the Institute, on the 11th inst.—Illustration of his Escapement Diagrams, which were presented by him to the Institute. The high importance and value of this Reading was duly appreciated by a large meeting of members. A Discussion on the reading will take place at the Institute on the 8th of January, 1861, which it is hoped will be attended with valuable results.

The Geometry and Drawing Classes have been eminently successful. The half-yearly examination proved that the pupils had made most rapid progress under the able tuition of their zealous master.

"The Council regret that several lectures and readings kindly promised during the past six months have been unavoidably postponed, but hope shortly to announce a course of Lectures by well-known professors.

"The Council desire to record their deep regret at the loss sustained by the sudden death of their highly esteemed and respected colleague, Mr. Adam Thomson, who ever evinced a warm interest in the progress and success of the Institute.

"The Institute continues to receive the countenance and aid of Her Majesty's Commissioners of Patents, from whom valuable presents have been added to the library lately."

GEORGE. E. MYLNE, *Hon. Sec.*

GENERAL STATEMENT OF RECEIPTS AND EXPENDITURE, FROM 15TH JUNE TO 15TH DECEMBER, 1860.

RECEIPTS.	£.	s.	d.
Balance at last audit, on 18th June, 1860	87	0	8
Member's Subscriptions and Donations	105	15	6
Sale of Journals, and Advertisements	46	18	3

	£.	s.	d.
Class Admissions	5	8	0
Rent from Mr. Palmer	10	0	0
Sundries	0	15	9
	£255	19	2

Expenditure.	£.	s.	d.
Rent, Taxes, Rates, and Fire Insurance	28	2	11
Furniture, Fittings, &c.	3	6	0
Coals, Gas, &c.	10	10	4
Palmer, for taking charge of premises	10	9	0
Printing, Engraving, and Binding Journal	54	3	9
Printing and Stationery	6	11	1
Postage Stamps and Receipts	4	16	6
Newspapers, Periodicals, and Advertising	19	2	4
Drawing Master's Fee	9	16	6
Salaries to Assistant Secretary and Errand Lad	43	8	6
Commission Account	5	3	6
Sundries	6	6	9
Balance in Treasurer's hands 52 17 10; Balance in Hon. Sec.'s hands 1 3 2	54	1	0
	£255	19	2

We have examined the above statement, and find the balance therein correct. D. M'Donnell.
Dec. 20th, 1860. F. Grimshaw.

The Chairman remarked that the balance-sheet showed a higher state of prosperity than that which existed at the last Half-yearly Meeting. He thought that, looking at all the circumstances of the Institute, there was a probability of its going on improving, which was an object they all had in view.

Mr. Marriott moved the adoption of the report and balance-sheet.

Mr. E. D. Johnson seconded the motion, which was carried unanimously.

The ballot was opened at 7, and closed at 9 o'clock.

Scrutineers.—Mr. Bishop, Mr. R. Strahan, and Mr. Charles Bacon were elected.

Votes of Thanks to the Retiring Officers.—Mr. Marriott moved a vote of thanks.

Mr. Clifton seconded the motion, which was carried *nem. con.*

Mr Storer returned thanks.

Auditors.—Mr. Jackson moved a vote of thanks to Messrs Grinham, McDonnell, and J. P. Walters, which was seconded and carried.

Honorary Secretary. — Mr. Klaftenberger moved a vote of thanks to a gentleman to whose exertions the Institute owed very much of its success—the Honorary Secretary, Mr. Mylne.

Mr. Kulberg seconded the motion, which was carried unanimously.

Mr. Mylne, in returning thanks, thought that the amount of work done scarcely entitled his services to such a recognition; but he hoped that by Midsummer it would be much greater.

Committees. — Mr. Hewitt moved a vote of thanks to the Journal, Museum, House, and Finance Committees.

Mr. Clifton seconded the motion, which was agreed to.

Assistant Secretary.—Mr. E. D. Johnson said, that whilst doing justice to the greater, they ought not to forget the smaller officers. He should be very sorry to withhold from a young man the thanks which he was entitled. He moved a vote of thanks to the Assistant Secretary, Mr. Middleton.

Mr. Jackson seconded the motion which was agreed to.

Mr. Middleton briefly acknowledged the compliment.

Ballot on Equality of Votes.

Mr. Jackson moved an addition to the wording of Rule VI., s 2, which is as follows:—"The duty of the chairman shall be to prevent all improper discussions; to examine the ballot on all questions subjected to it; to maintain order and regularity in the proceedings; and to give the casting vote in all cases of equality." He proposed to make the following addition to the clause:—"Except in the case of the election of officers referred to in Law VIII., s. 5," which law ran thus:—"If upon the announcement of the numbers, two or more gentlemen should have an equal number of votes, one or more additional ballots shall be taken by the members present on the gentleman so situated." His object was to prevent the informality which had occurred on a former occassion. The importance of the election of officers made it a matter which ought to be excepted from the rule respecting the chairman's casting vote, which in all ordinary meetings was the mode of decision in cases of equality of votes. Upon the last occasion they were not so well versed in the law as they were then.

Mr. E. D. Johnson could second the motion without any change of opinion Mr. Jackson's resolution would render that unmistakeable which at present was not clear. He (Mr. J.) knew that, except for the withdrawl of Mr. Crisp, his own election as Vice-President would have been illegal.

Mr. Clifton thought that there could not be two opniuns as to the expediency of the proposed alteration. Upon the last occasion the meeting seemed undecided what course to adopt, and had it not been for Mr. Crisp's withdrawal, the election of Mr. Johnson would have been illegal. Had the eighth law then been read by the Secretary before the election commenced, they would not have fallen into the error.

The result of the voting by ballot and show of hands was.—For the motion, 21; against, 6.

Abolition of Proxy Voting.

Mr. E. D. Johnson said, that the gentlemen present were, no doubt, in possession of the wording of the motion he proposed. He was glad that Mr. Jackson's resolution had preceded his own. He was desirous of separating the two modes of voting. He looked upon vote by ballot as amongst classes which always would exist as desirable, for the purpose of meeting undue influence in any class where several classes, such as employer and employed, must vote for a common cause. The best way was to steer clear of class. But that need not be mixed up with voting by proxy, which might be a very good thing, but which yet might be converted into a very bad one. At any rate it made the unreasoning vote equal to the most intelligent one. It had been said that

non-proxy voting was depriving the poor man of the power of voting; but he had his eye upon the difficulties of the rich as well as those of the poor. Whatever affected the one man affected the whole community. The man who brought time, energy, and brains to the business of such an Institute as that, must certainly be better qualified to vote respecting its affairs than the man who had never thought about its affairs. If it were not so, he should like to know when it had been decided that two fools weighed more than one philosopher. He cared not how the man whose powers of reasoning, or industry, or interest in the Institute, who had devoted to it the greatest portion of time, influence, and everything that could raise it in the public sympathy, voted by the use of the proxy at the worst. He would set on one side the voting of such a man. All decisions now turned on the counting of noses. There was no degree of absurdity which he could propound stronger than the case merited, or to which it was capable of being applied. Supposing he was narrow-minded enough to feel spite towards the Institute; that he was one of those envious dispositions who would rather see the Institute destroyed than be saved at the hands of others; he would tell them precisely how he would act. He would suppose himself a large employer of labour, or that he had an extensive acquaintance amongst watch makers who possessed votes; it would only be necessary for him to propound some absurd and ruinous question, such as to move that the Council of the Institute should postpone its next meeting until that day twelve months, which would bring ruin upon that or any society which was left without government for so long a period —and it would be done. Statistics proved that however clamorous men might be for the franchise, they where very indifferent as to its use when they had it. In any case two-thirds of the number of votes polled was a voluminous election. Supposing the arguments were nicely balanced, and there was an equal number on each side, they would find one hundred out of the three hundred to canvas for proxies. These gave the opportunity for this application of the proxy system. He would now go back to the case he supposed, of the ruinous resolution. Did they suppose it would be necessary for him to come before a meeting and argue the question? By no means; he would apply so many pounds, shillings, and pence, and a "fico" for their arguments; he would put in his proxies, and the question would be carried. At the present moment they were in that position of absurdity, for they were arguing a question which was being decided by the scrutineers upstairs. Again, he believed that it must be confessed that that and all young Institutes must depend entirely upon the vigour, activity, energy, acquirements, sympathy, and capital of a few individuals; it consequently followed that personal influence must have a large share in giving confidence to the general body politic. He would suppose, for example, that a gentleman who had departed this life, for he would not take a living man for illustration. But suppose the late Mr. Vulliamy was alive, and it was exceedingly desirable that he should be president. He was duly nominated to the office; somebody conveyed to him the information that it was competent to another person to propose as a candidate any other member who had paid his subscription. Tom, Dick, or Harry, proposed some man, victory over whom would be no credit, but being conquered by whom would be simply absurd. Under these circumstance the greater man would resign, and leave the members to elect the sweep. That election would be determined not by a man's merits, but by canvassing, and voting by proxy. No case could be adduced in which greater absurdity arose. The unreasoning votes had as good a chance of acceptance as the intelligent votes of the members present, who would be voting intelligently instead of just hap-hazard. He felt a strong conviction that the law must be altered, otherwise the handle which the present system gave for the perpetration of folly would be the ruin of the Institute. He moved "That in alterations of laws, and the election of officers, no member be allowed to vote, unless present at the meeting at which snch alteration or election is decided."

Mr. Mylne, in seconding the motion, endorsed every word uttered by Mr. Johnson. He (Mr. M.) had had practical experience of the mischievous working of the voting by proxy. At the last meeting in August proxies were brought in by the dozen, and put before him, procured by parties through canvas. He knew from experience that upon that occasion proxies were positively misused The absurdity was perfectly clear, because whilst they were in the midst of the discussion of the several questions of which notice had been given, the scrutineers were waiting in the room to announce the result of the ballot. Voting by proxy was not at all needful for persons resident in London. It might be objected that it was the only means open for country members to vote, but he had had an opportunity of seeing the country members, and he generally found them positively decline to vote, saying that they were not in a position to do so, in as much as they did not know the merits of the various propositions. But to give men living in Spencer-street or Ashby-street proxies was most mischievous.

Mr. Brooks had heard of the proposition with some degree of surprise. If surprised at its emanating from the originator of the Institute, he was certainly equally surprised at its having been seconded by the Honorary Secretary. To assert that proxies were misused at the last election was a most serious charge against some one, and if the Secretary knew who it was, he should like him to name the person. For himself he knew nothing about it, and therefore would not make such an allegation. But if the proof of misuse was to rest simply upon the fact of the balloting papers having been brought in by the dozen, then the August meeting was not the first at which such a course was pursued. He was as strongly opposed to the practice of proxy voting as Mr. Johoson was. He (Mr. B.) had over and over again refused to vote for any subscriber who had requested him to do so and enclosed his paper for the purpose. No one could object to the argument used by Mr. Johnson, that proxies were bad, especially where they were entrusted largely to any individual. If the present law was an evil, the remedy was a worse one. What was it that was proposed

to be done? In the most liberal parish in London, they were asked to propose the most despotic resolution—a simple disfranchisement of members. If there had been any irregularity in the preceding election, let it be altered, and let measures be adopted for its future prevention, but let them not deprive members of their rights. In a short time they would have in Clerkenwell the government of Naples resuscitated There were other ways of remedying the present evil. Some reference had been made to large employers of labour; could they not, under the proposed system, request their men to come and vote, and would they not be obliged to do it? Such things had taken place, and human nature was human nature still. Let them look at the power which Mr. Johnson's motion would give to one individual employing a number of hands; he could pay their subscriptions in order to get their votes. Might he not thus govern the entire Institute, and become its Bomba, governing it with as much arbitrary power as the King of Naples had done? If they took that step it would not be long before they would hove to close the doors of the Institute. If there was one privilege which more than another the members of the Institute should prize, especially those residing in Clerkenwell, it was the right to vote. His experience of the interest taken in the Institute by country members differed from that of Mr. Mylne. It did not take them long to form an opinion as to whether Mr. Cole, for example, was a fit and proper person to be one of the Vice-Presidents, or whether Mr. Johnson the originator of the Institute, should be elected to the same position. Neither was there any great difficulty in their judging of the merits of a resolution submitted to them. They were not to treat men as possessed of no brains because they lived at a distance.

Mr. Marriott was anxious to have attended an engagement elsewhere, but feeling the importance of the question under discussion to the interests of the Institute, he had resolved to be present He accorded with a great deal which had been advanced by Mr Brooks, who had taken much of his argument out of his mouth. Every member was entitled to a vote, but if the resolution was passed it would prevent many from exercising that valuable privilege. If the proxy voting was taken away they would still have room for that which they wished to prevent, the decision of questions by a packed party. If what had already been said of the scheme was published, he did not know what the trade would think, or how they were to carry on the affairs of an Institute of that kind. He had consulted no one, and was only speaking his own feelings on the matter He should be glad to propose the following amendment:—"That in the alteration of laws, and in the election of officers, no member shall be allowed to vote until one week after the publication of the Journal, that all members may know, after the discussion at the meeting, how to record their votes." As had been said, it was an absurdity to discuss motions which had already been settled by ballot or by proxy votes. Last time he did not record his opinion; this time he had done so. Why should not the Journal be made availabie for the purpose? Would they not, in a week or a fortnight after readiag the arguments, be enabled to judge themselves as to the merits of a question?

Mr. Jackson should feel great pleasure in seconding Mr. Marriott's amendment. He certainly felt the force of Mr. Johnson's clearly defined objection, and the difficulty in proxy voting of getting the sense of the meeting; but the entire abolition of the proxy system was quite another matter. It had been said that great law-makers were generally great law-breakers. Their friend Mr. Johnson had been mainly instrumental in laying the foundation of the Institute, and the very principle he was seeking to abolish he was to a certain extent responsible for. In the history of the Institute, the first notice of motion which put the axe to the root of any law had been given by that gentleman. The motion was not a modification of a principle, but a decided blow against a system. The Council had the power of electing and excluding members, but the members had no influence excepting by the vote. It would be very easy to pack a meeting and buy votes, and record them by proxy. Every good system was susceptible of abuse. Where was the difficulty in abusing the vote by ballot, as was very plainly and forcibly put by Mr. Brooks? Anybody could purchase a number of votes. The motion would lead to a system of centralization; it would render the Institute exclusive. If Mr. Johnson's system was carried out he would recoil from the effects of it hereafter. As to the election of officers, it wanted no argument for gentlemen to come to an opinion as to their eligibility. He made those remarks with all respect to the honourable Vice-President who had brought forward the motion; but having sat in the Council for a great length of time, and taken great interest in the Institute, he thought Mr. Johnson would give him credit for anxiety for its welfare.

Mr. Clifton regarded the motion as an attempt at a wholesale disfranchisement of the country members. They would not be in the difficulty in which they then found themselves if the discussions upon every question were previously reported in the Journal, and sent into the country. The country members would then be able to form an opinion upon every question, and they would thus have the benefit of their judgments; that would give them an interest in questions which it was said they did not at present possess. The question was pretty well discussed at the last general meeting, Mr. Gordon's motion being similar to that of Mr. Johnson, it being that the treasurer should be elected yearly by a majority of the members present; but only one vote was recorded in its favour, and that was Mr. Gordon's own. He (Mr. C) had come there with very great difficulty, having another engagement, but he thought he should like to raise his voice against the proposed alteration of the law. Some parties were not present through illness, and others on account of the severity of the weather. There were many causes which would prevent a member attending a meeting. But supposing, as Mr. Brooks had said, a number of persons had come to pack it; that would be a greater absurdity than proposing the postponement of the meeting of Council for the

twelve months, to which Mr. Johnson had referred. He did not say that any man would be guilty of such an act; but the door would be opened for their meetings to be applied to such a bad purpose. Mr. Mylne had asserted that votes were brought in by the dozen. He (Mr. C.) did not know how that was; he had voted according to his conscience, and he was not sure that other people had not done the same. If a workman was obliged to give up his paper to his master he was merely a white slave He was not to be bought in that way, and he did not know that others were. He might have given his balloting paper to a member to place before the Chairman, but that did not show that he had not first signed and filled it up. The present motion might have been brought forward when there were not more than half-a-dozen persons present.

The CHAIRMAN said that Mr. Clifton had spoken in a very clear and definite manner. There was a decided difficulty in the case. The proposition of that gentleman for discussing all questions of importance and inserting a report in the Journal, would give every member an opportunity of considering the right or wrong of the question. That appeared to be the best mode of dealing with the difficulty. How far it could be carried out with a ballot it was not for him to say. He hoped that if any gentleman could make a practical suggestion for the removal of the difficulty he would do so.

Mr. STORER corrected the Chairman; the proposition originated with Mr. Marriott, and not with Mr. Clifton.

Mr. JACKSON urged that the sense of the meeting should be taken upon the amendment.

Mr. MYLNE could not see how that could be done in conformity with the rules.

Mr. JOHNSON in reply said that with regard to the supposition of Mr. Brooks, that under a system of open voting a large employer of labour might send in his men and pack the meeting, he (Mr. J.) would ask nothing better, for he had not so low an opinion of them as to believe that they would not vote conscientiously. Supposing a gentleman to pay the subscriptions of a majority of the men, ought he not to reign paramount? It would be his Institute, and glory be unto him. With regard to the country members, had they not received already the consideration of pounds, shillings, and pence in exchange for their privilege? In the first place they only paid two-thirds the subscriptions of the London members and they received back in the Journal an equivalent value of 5*s*. out of the 8*s*. subscribed. It was all very well to make a stalking-horse of the interest of other men; that interest generally lay under the satin of their waistcoats. He (Mr. J) went for the interest of the Institute, and not for that of any class of its members merely. Was it anything to the country members who sat at the Council board, provided the Institute flourished? He had put scores of proxy papers, sent up to him blank, into the fire. It was all very well to grant the franchise, but there was great apathy in the use of it. Mr. Marriott agreed with Mr. Brooks about the injustice of disfranchising the country members, but they could record their votes *viva voce*. If the discussion was published previously to the vote, it would amount to much about the same thing. Every petty question would require two special meetings to settle it. Were they prepared to multiply their meetings *ad infinitum*.

Mr. MARRIOTT.—They would not be wanted for petty questions.

Mr. JACKSON.—Only half-yearly,

Mr. JOHNSON repeated, that however insignificant the question, it would require two special meetings to settle it—one for the argument, and the next for the vote. Mr. Jackson had given him (Mr. J.) the hardest hit of all, namely, that he was responsible for the form of the rule, because he was on the law committee. He begged to assure Mr. Jackson that he had tried pure democracy. On the ground of being all things to all men they had tried to place themselves above suspicion, but he could assure them it was not without grave suspicion and doubt as to the way in which it would work. The result had been their present position of difficulty, which, however, he did not think was irremediable. He could not enter into the difficulty of the last election, because his name was mixed up with it. Mr. Clifton's objections were the same as Mr. Marriott's, and so were Mr. Jackson's and Mr. Cole's. He (Mr. J.) only advocated the change upon principle; he had not attributed bad motives to any man in connection with the present system. He had desired to inform his own mind, and to give them data for every statement he made. He asked them to vote in common deference to their intellects. He hoped that the preliminary step would that day be taken for the abolition of the proxy system.

Mr. CLIFTON thought that the amendment could not be put to the vote according to the rule.

Mr. BROOKS suggested its withdrawal, and that the Council should take the matter into consideration and suggest some alteration.

Mr. JACKSON thought that that would be a very good course to adopt.

Mr. GUILLAUME could not see how the amendment, of which no notice had been given, and of which the great bulk of the voters knew nothing, could be put.

The CHAIRMAN thought that the question had better be dropped on both sides.

Mr. MARRIOTT assented to the withdrawal of the amendment.

A show of hands of the members who had not voted by ballot was then taken on Mr. Johnson's motion with the result of—2 for, and 1 against.

The numbers, as declared by the ballot, were—11 for, and 21 against.

ANNUAL ELECTION OF OFFICERS.

Mr. KLAFTENBERGER, as a member of the Council, had seen the evil of frequent changes of its members. Half-yearly elections were too often. By the time a member got into working order his term of office expired, and his re-election was a matter of doubt. An annual election would be far better. He moved "That the election of all officers, take place once a year only."

Mr. BROOKS seconded the motion. The reason they had had half-yearly elections was, a fear lest, if annual, there would be no one left to conduct

the business; but experience had shown that there was no ground for any such apprehension.

Mr. Jackson inquired how, in the cases of members failing in the required number of attendances, their places were to be filled up? Supposing that three months after the election, ten gentlemen were struck off for such defaults? Were the vacancies to be filled up temporarily by the Council?

Mr. Mylne replied, that the average loss from that cause was three members in six months But supposing ten were disqualified through non-attendance, there would still be eighteen, a working number, left. By the law, special meetings to fill up vacancies might be held. He quite agreed with Mr. Klaftenberger, that the semi-annual elections were objectionable.

Mr. Jackson thought the remedy worse than the evil. They were bound by the law to call a special meeting.

Mr. Mylne said that the Council were not obliged to call special meetings; it was left optional with them to do so or not.

Mr. Johnson apprehended that there was a little mistake respecting the purport of Mr. Klaftenberger's motion, which did not go to the removing of the whole of the Council, but to make the tenure of office, in fact, biennial. He agreed with that gentleman, and desired to record his opinion accordingly. Of course their present discussion was, like all the others they had had, a "chip in porridge," because the matter was being settled for them upstairs. The present tenure of office was too short, not for individual gratification, but for the welfare of the Institute. A man got into order and understood his position, and then out he went. By the time that the members of the Council had begun to work harmoniously, one half of them went out, and new colleagues were brought in for the residue. It took some time before men pulled together in harness.

Mr. Mylne. Mr. Klaftenberger's motion is that the election of "all" officers should take place once a year.

Mr. Johnson thought that it did not alter the law of retirement, only it would be annual instead of half-yearly.

Mr. Mylne said, that as the President, Vice-president, Treasurer, and Honorary Secretary were elected annually, it would follow that the Council would have to be elected with them, to have the election of all officers take place once a year only, and all would be eligible for re-election.

Mr. Klaftenberger admitted that such would be the result of his motion, if carried.

Mr. Guillaume thought that the working members would generally be re-elected. He had no doubt that most persons had voted upon the motion in the ballot under the idea that the whole of the Council would go out annually.

The result of the ballot was—28 for the motion, and 4 against.

Mr. Johnson moved a vote of thanks to Mr. Farmer and the Press, which was seconded, carried, and replied to.

Council Election.

The Scrutineers having completed their duty, the Chairman declared the following result:—

Council to be Elected for Twelve Months.

Messrs. C. Guillaume, 42; J. Trewinnard, 42; D. Clarke, 41; W. Hislop, 40; E. Storer, 40; T. Gordon, 38; A. Walsh, 38; J. Murray, 37; R. Webster, 35; George Frodsham, 34; H. Richards, 34; R. F. Warman, 33; W. P. Birchall, jun., 33; T. Leonard, 32.

Elected to Serve for Six Months.

S. A. Brooks, 31; R. Strachan, 30; R. Howard, 27.

Candidates not Elected.

J. F. Watson, 27; G. Bruton, 25; D. Gunton, 25; F. Potter, 22.

Messrs. R. Howard and J. F. Watson having an equal number of votes, a ballot was taken by the members then present (at 10 30), when the Chairman reported that there were 6 votes for R. Howard, and 5 for J. F. Watson.

Thanks were voted to the scrutineers and the chairman, and the meeting adjourned.

REPORT ON THE EXAMINATION OF THE GEOMETRY AND DRAWING CLASSES.

To the Council of the British Horological Institute.

Gentlemen,—I have to inform you, that I met the following gentlemen at the Institute, on Friday the 14th instant, for examination of the Geometry and Drawing Classes, and for awarding the prizes which had been placed at your disposal.

Present Messrs. Gordon, Jackson, Storer, Guillaume, Schweizer, Roberts, and Mylne.

I have the pleasure of reporting to you, that after a rigid and careful examination of the Pupil's drawings, it was determined that, in consideration of Master Crisp having had the advantage of one year's prior instruction in drawing (from Mr. W. S. Hoare), he at the present time was considered not fairly eligible as a competitor, but entitled to a prize for his general proficiency, which accordingly was given to him.

The order of competition, decided by merit, stands as follows;—

Prize for greatest proficiency in Geometry.

To Master Thomas Wright.

For Mechanical Drawing.

First Prize..... to Master Alexander August Klaftenberger.
Second do...... to Master James Haswell.
Third do....... to Master Thomas Wright.
Fourth } equal { to Master B. Colyer.
Fifth.. } equal { to Master John Morrison.

The above pupils, (the first and second) expressed their wish to have a book instead of the class free admissions, which was complied with, and the Honorary Secretary, on your behalf, placed the other books as prizes at our disposal.

In reference to the pupils of these Classes, I cannot conclude this report without recording the evidently great progress made by them since our previous examination, at the termination of the first quarter; and I feel it due to Mr. W. S. Hoare, to express the general opinion of this committee that the advancement observable is consequent to his well applied exertions. I am, gentlemen, your's faithfully,

JAMES F. COLE.

December 15th, 1860. *Chairman.*

MR. JAMES F. COLE, V.P. ON THE LEVER ESCAPEMENT DIAGRAMS PRESENTED BY HIM TO THE INSTITUTE.

The following important and highly interesting paper to horologists was read by Mr. JAMES F. COLE, by invitation of the Council, at the Institute, on the evening of Tuesday the 11th ult. Mr. E. D. JOHNSON, V.P., in the chair.

Mr. CHAIRMAN and GENTLEMEN, Subsequently to the Lecture I had the honour of delivering to the Members of the British Horological Institute, in June last year, I presented to the Institute the diagrams employed by me on that occasion in illustration of the Principles of the Detached Lever Escapement; and at the same time, having promised to give further explanatory details relating to the subject, I with much pleasure avail myself of the present opportunity of fulfilling that engagement.

As introductory to the additional remarks I have to make this evening, in continuation of my former papers, I do not intend confining my observations strictly to the one question of the detached lever escapement. I prefer to adopt this course, conceiving the advantage or disadvantage of a principle to be made more apparent by comparison. I might also add that the greater portion of my intended remarks for this occasion will be offered as the results of practice and experience, with the view of avoiding as much as possible wrong conclusions, which too frequently occur as the result of mere theoretical inquiry.

As the former papers, just mentioned, have appeared in *The Horological Journal*, and also in other publications, the views taken by me in reference to the detached lever and some other escapements, and the general principles of time-keepers, may possibly have fallen under the notice of many of the Members now present; it will not, therefore, be necessary on my part to do more than recapitulate the heads of the several divisions, supposing the general purport already sufficiently understood. Should this not be the case in every instance, it may readily be seen by referring to the Report of the Lecture, published in Volume I of *The Horological Journal*, pages 150 to 156, noticing in the following order:

1st, Vibratory motion of balances as the effect of elastic force in watches, chronometers, and all portable time-keepers; oscillatory motion of the pendulum as the effect of gravity in clocks.

2nd, Natural laws referring to force and resistance; effects of change of temperature on springs; their acceleration or rate, &c. Brief descri tion of the chronometer and watch movement. Escapements of various construction mentioned, with a description of the remontoire escapement, and reasons for discontinuing its use.

3rd, Mechanical effects of escapement lockings on the motion produced at the balance, and on the balance spring, as interfering with the isochronous result on time, and showing the necessity of care in the due formation of locking angles.

4th, The rack lever escapement, mentioned as the production of Dr. Hooke or Huyghens, and the detached lever escapement as the invention or improvement of Mudge.

5th, Remarks on the proper diameter and weight of balances, relatively to the speed or velocity of the respective trains employed in the construction of time-keepers, such diameter and weight falling under the general head of proportions, as more fully explained in my former paper.

6th, I now come to that part of the paper treating especially the principles illustrated in the Diagrams before us, which is properly and chiefly the subject for consideration in my present Reading; which I cannot offer as a thorough dissertation, as I should have to repeat too much of the subject matter contained in my previous Lecture.

The Diagram No. 3, now under consideration,* represents a Detached Lever Escapement with long arc pallets, having, by reason of the particular direction of the impulse planes, 12 degrees of motion at the pallets and lever, including the locking quantity of motion on each side, technically known as the supplementary arc; in other words, the entire arc of motion from drop to drop of the

* For diagram, see vol. i., p. 154.

wheel teeth in action; 2 degrees of hold upon each locking being fully sufficient for sound detention, will leave 10 degrees of effective impulse of the wheel on each pallet in either direction of the pallet and lever motion, while 36 degrees will be the ultimate arc of motion as the escaping action at the roller and balance, including the supplementary arc on each side, the entire arc of vibration being the result of momentum induced by the impulse power. One degree of hold for the lockings may, however, be preferred for very exact work. In this figure the driving plane of the first pallet for producing 12 degrees of motion at the pallets and lever, is a line direct to the delivery point of the second pallet, it being impossible to produce that amount of motion by any smaller angle, though it may be done improperly by pitching the escapement wheel and pallets too deep. What I have just stated is clearly shown by the scale of degrees given on this diagram, this scale being generated, first, by a right line drawn from the delivery point of the second pallet through the pallet-axis or centre of motion, such line being the base of an equilateral triangle, and an arc drawn from its apex (the delivery point of this second pallet) as a centre, and extending from any point on the base line to the opposite side of the triangle, forms an arc geometrically known to contain 60 degrees. I adopt this figure as a convenient mode of obtaining a scale which is here divided into fifths, as figured, two divisions being 24 degrees. I must he.e observe that 24 degeees on this scale, in mechanical effect represent only 12 degrees of pallet motion, as a consequence contingent on the diagonal action of a tooth or point passing over an inclined plane of this particular order. The discovery of this remarkable fact led to my constructing a simple instrument, in which the blank steel for pallets of all ordinary sizes could be placed, and readily filed to any desired angle, by setting an index to a scale of degrees engraved on the tool, by which the angle may be tested. The second or long pallet thus formed becomes a standard, with which the first or short pallet must be filed to agree, in such manner as will allow the wheel-teeth to escape and lock uniformly on each side; and impulse power from the wheel, acting on these angles, will be sufficiently uniform in their effect upon the roller and balance for practical efficiency, though a somewhat more exact uniformity may be produced by substituting a slightly convex curvature for the acting face, instead of the ordinary plane for the first or short pallet only, and leaving the long pallet plane quite straight as usual. As connected with the formation of lever pallets, I need but mention that the method used in the customary course of manufacture, for giving the required arc of pallet motion, is to make the impulse plane of the first or short pallet to direct the line of its face to some known point on the second pallet; this line of direction being ascertained by mechanical trial, is then recorded as a working rule for the first pallet (contrary to the former method), the second angle is then formed from it, so as to allow the wheel-teeth to escape and lock uniformly, as before described.

The next point of importance to which I will call your attention, is the necessary rule for determining the relative proportions of the lever and roller, as shown in this diagram (No. 3), in which the great circle represents the circumference of the balance, its diameter corresponding with the external diameter of the main spring-barrel, as suitable to chronometer and watch movements of the half-plate or three-quarter plate construction.

Working Rule.—Divide the balance diameter into seven equal parts, and three of those parts give the diameter of the escape wheel; its diameter, therefore, in this case, is three-sevenths of the balance, and from the wheel, as a gauge, the proportions of the lever and roller are deduced; this is done by taking the distance or chord of four teeth from point to point, as the distance proper for the pallet staff from the roller and balance axis; next, draw a right line from one of these centres of motion to the other, in accordance with the line shown on the wheel as the chord of four teeth, and dividing the line of centres in like manner into four equal parts; the first part or first division from the centre of the roller is the exact place or radius of the impulse ruby pin; the remaining three parts or divisions show the proper length for the impulse arm of the lever, which is limited in its extent of motion to the arc of 12 degrees, just sufficient for allowing the free escape of the wheel teeth, when the acting end of the lever is checked by the banking pins fixed in the frame plate, one on each side of the lever; this position of the pins I prefer as causing fewer repetitions of the banking, when the momentum of the balance is checked.

By the proportions here given for the lever and roller, the arc of impulse at the balance is multiplied, in the ratio of three to one, and producing by further multiplication of the degrees at the 12 pallets and lever 36 degrees as the ultimate arc of escapement. And I may here observe, that though I have pointed out the advantage of short arc escapements in my former paper, as allowing a higher multiplication and a larger amount of free vibration to the balance,*I do not urge this argument as an arbitrary rule; nor do I seriously object to the use of long arc pallets, when the lever and roller proportions are suitably proportioned. The outer central circle on the diagram is the circumference of a common table roller, for detaining the lever on either side by an ordinary upright guard pin; this, though called the safety action, is, from the delicacy of so shallow an intersection with the roller, questionable in point of soundness, and in many instances the detention of the lever is only rendered safe by an improper depth of run upon the lockings. The inner central circle is intended to show how easily so evident a defect may be remedied, simply by fitting a second smaller roller lower down on the balance axis, and not larger in diameter than to reach the back of the ruby pin as its radius, as seen in this figure; in which the first-mentioned roller is now only required for carrying the ruby pin, and may otherwise at discretion be formed as a radial arm; the second, or detaining roller, having the passing-hollow cut as a semicircle of no greater width than will allow proper liberty of passage to the guard pin; care, however, should be taken to fix this gold pin firmly in an oval-shaped hole, in order to prevent displacement after being bent over to correspond with the small roller edge. A few more remarks will show that the pallets in this diagram (embracing three teeth of the wheel as usually employed) should in all cases be care-

fully examined as to correctness of the locking angles, as affecting the draw by pressure of the wheel-teeth, which of course must be just sufficiently under-cut to ensure perfect detachment of the guard pin and roller. Having now described the working rule of proportions, and the various points of action requiring care in execution, I trust it may appear that the detached lever escapement, made strictly in accordance with the principles and proportions given in this description, would not fail to perform satisfactorily.

I may here mention that any principle, if carried to an extreme in either direction. will generally be found productive of other defects than those for which a remedy is intended by the supposed improvement; and therefore it may be unadvisable to employ pallet angles so great as to produce an arc of lever motion equal to 15 degrees. This however is quite practicable, provided the lever and roller proportions be such as to produce in this case (say) from 30 to 36 degrees as the scaping arc at the balance; and under this view, if 30 degrees be determined on, there being 15 degrees in the pallet arc, all that will be required is to pitch the centres of the pallets and balance nearer together, taking as a rule the chord of three teeth of the wheel instead of four, previously mentioned as a proper length for the line of centres, and dividing that line into three equal parts. The first point from the centre of the roller will be the radius and place of the ruby pin, the remaining two parts giving the length of the impulse arm of the lever. Under these proportions the mechanical effect could not be otherwise than correct; and, from the larger arc of the lever and deeper intersection, the detention would be quite sufficient without the double roller. The multiplication in this arrangement for pallets of 15 degrees being as two to one, will of course produce 30 degrees as the scaping arc at the roller and balance.

There exists, however, some slight objections to this, which led to my preferring the use of 8 degree pallets. 1st, The pallet angles being more acute, the wheel has a less determined action on the diagonal planes. 2nd, The acting surface being greater, and the effective impulse less, glutinuous oil will more readily reduce the vibratoty motion. 3rd, By the shortened lever and deeper intersection, the locking resistance will be proportionably greater.

Notwithstanding these objections, I have reason to consider that a lever watch made with an escapement of the proportions now explained, provided that the motive power, weight of balance, and strength of balance spring, be such as to prevent setting on the impulse or lockings, and to produce one turn and five-eighths of vibratory motion of the balance, would answer mechanically well; and as there would be some advantage in the greater soundness of the detention, there would be no working difficulty in its production. I should therefore, not hesitate to adopt 15 degree pallets, with such proportions as I have just described for the lever and roller.

Having now said as much as may be required in illustration of the principles of the detached lever escapement, I am desirous of submitting the result of my experience during about four years' working of an improvement shown in Diagram No. 4. *

* See vol. i., p. 155.

My object in noticing this is not to enter into miute particulars, as what has already been stated in reference to angles and proportions for the ordinary detached lever principle will, with only one exception, equally apply to this, which I believe is now to some extent known as the resilient lever escapement. The exception, I allude to is, that the pallets here employed have in general, short angles of only 8 degrees (though 10 are given in this diagram), and properly so, when the escapement is made with this particular kind of wheel, known in the trade as the resilient wheel, the front portion of each tooth in which, below the locking recess, is cut at an angle, given by a line direct to the extreme point of the fourth tooth in advance; this direction of the line I found (by experience in various forms) to be preferable to any other; and therefore short arc pallets were preferred. in order to prevent the second impulse-plane checking on the front line of the tooth, as it would do by the recoil action, which only occurs when the balance is casually thrown into more than two turns of vibration by external motion of the watch, and to prevent adhesion of the pallet planes by glutinous oil.

Although the ordinary lever escapement goes wonderfully well, just give the watch a little circular motion and see what it will do. Why, in a minute it will gain twenty or thirty seconds. If you happen to be riding or walking fast with such a watch it may gain some seconds, and there is a doubt in your mind whether the same effect may not be produced in it to a certain extent under ordinary circumstances. In some of the very best watches made upon the ordinary lever principle, when they have had a heavy balance, and have vibrated to the extent of a turn and three-quarters I have found it difficult to move from one side of the room to the other without producing the banking error. I have found the watch run three or more seconds before I could get to the clock But to my great delight, when I first made the escapement upon the resilient principle, and put it to the same test, it made no difference at all.

Here is a resilient lever watch which you can test if you have a chronometer; you cannot make a difference in it if you try for an hour. I can see no obstacle in the way of the workman producing this to perfection if proper rules are attended to. Can you make a chronometer of ordinary construction do as much? Certainly not.

A gentleman came to me with a very fine chronometer, and said to me, "Mr. Cole, I have had this watch from your hands only very lately; but I went to an evening party, and towards the close when I took out my watch I found it was three hours too fast." From external agitation, the balance of his chronometer had gone over the second revolution.

We may obviate this very palpable objection in time-keepers by adopting my non-repetition principle. The duplex will over-run like the chronometer. Not only do they make wrong time, but the watch is subjected to injury. You may bend or even break the pivots or ruby pin. I do not want to speak of a matter of this kind otherwise than fairly. I do not speak from sinister motives. I should like to see the art of Horology advanced to such a point of simplicity and perfection that

the British manufacturer should be enabled to compete with the foreigner, and be enabled to vend watches at corresponding prices with him. That is my motive in wishing improvement.

Having said so much about the principle I need not add anything further upon it. I will now point out my mode of simplifying the lever, by doing away with the guard pin. It is very analagous to what is done in the commonest foreign watch; but differs materially from it in having the guard point before the notch, instead of behind it. The lever here is made of a much thicker piece of steel than is ordinarily employed. It will be as thick as the pallets themselves; in consequence of that it will have to be filed and cut to the ordinary thickness, except at the acting end.

The Lecturer then described from the diagram the process, which without the drawing cannot be made intelligible.

I hold in my hand a letter from a gentleman whose watch I made upon this principle, and who informs me of the result of his observations upon its action.

"Dacre House, Lee, Kent.
" *Dec. 9th*, 1860.

" Sir,—I have much satisfaction in assuring you of the very unusual accuracy with which my watch now keeps time, as compared almost daily with the magnetic clock, which discharges the ball of the Royal Observatory, Greenwich. You will remember that the new escapement, on the resilient principle, was substituted for the original simple lever action, towards the end of February last, and I believe it will be difficult now to produce a watch, constantly carried in the pocket, superior to my own. Nov. 7th, My watch was in exact accordance with the Royal Observatory clock. Dec. 7, It was slow by the same clock, four seconds. During the whole interval there never has been four consecutive days without a comparison.—I am, sir, your's obediently,
" Chas. Thorold.

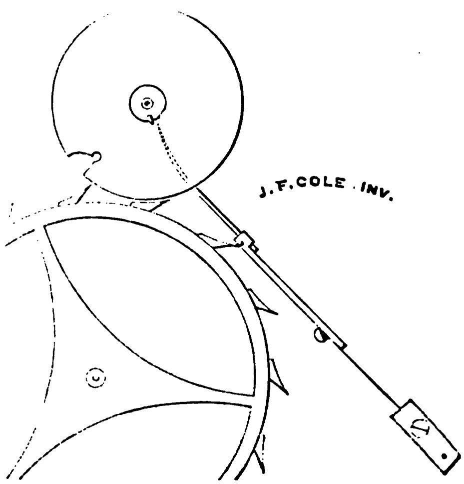
" To Mr. J. F. Cole, 29, Devonshire Street,
" Queen Square, Bloomsbury."

I have several other letters to a similar effect.

I might say a few words more in addition to what I have stated in the early part of this paper upon the comparative principles. In the lever escapement, power is administered to the balance through the medium of an intervening mechanism. In the chronometer escapement, the wheel acts directly on the roller, and the teeth are locked in a manner which renders it quite free to pass; but the moment the locking is disengaged, the wheel tooth, from the power applied, passes through the whole intersection. In that way there is nothing to impede the motion, as there is no diagonal action. Anything that could be devised that would do away with the working difficulties of the present principle (if simplicity and good effect are secured) would, of course, be desirable. The commonest things in the trade will go; but if you would have a good thing, it requires care to make, so that it will continue its action properly. Take, for example, a watch made improperly, and endeavour to correct it; you may make it through before you can do so. I have spent more time in rectifying such defects than it would have taken to make entirely new.

I am speaking of the comparison between the chronometer and lever escapements, as regards the mere transmission of power. In the lever it is done by the intervention of pallets, while the chronometer wheel acts directly upon the roller. Where the impulse of the tooth is made to act upon an incline plane, it will have a different effect in proportion as the angle is greater or less. If you could conceive a positive right angle and no incline, the tooth falling dead upon it would produce no motion. If the line is in the contrary direction (a tangent) the wheel will pass on, producing no effect. Any departure from those two conditions of the plane, will be effective in prdoucing motion in lever pallets, the plane being longer or shorter as the angle arc of motion is greater or less. If the angle is 45 degrees, the effective force will be only about half what it would be if acting direct. In the one condition the wheel expends all its force on the balance, which is not the case with a wheel acting on diagonal planes, as the intensity of touch would be variable on different angles; and by creating friction, the effective value of the force would be rather less. This is the distinction between the direct and the angular actions. The chronometer wheel has a rubbing action, of double the depth of its intersection; still there will be less friction and loss than in the lever escapement mode of impulse.

As regards the chronometer escapement, I have an observation to make on the locking spring. Its difficulties are known to every workman, however skilled. The locking spring is a complicated thing, inasmuch as it is made up of two springs. We have to adjust them together, and it is very nice work. If anything could be done to get rid of the second spring, it would be of great advantage to the escapement maker. I speak from actual experience, having done it for more than ten years. Although I never spoke of the plan until about a week ago, I shall have no hesitation in laying open my improvement, which consists in the disuse of the ordinary passing spring, and also the usual banking piece and screws; the banking, in my plan, being only a simple pin in the frame-plate for the front of the locking spring to fall against as a fulcrum, its position being at some point in a line between the locking stone and blade of the locking



spring. The locking will be just as determinate as before; the discharging pallet lifts the locking spring by acting immediately on the usual horn of the spring, the flexure for the passing action being entirely in the blade, beyond the fulcrum or banking pin; various positions within the points mentioned will answer for the place of the pin, which a trial will prove.

In showing you this, I hope I have said enough to be sufficiently understood; and I do not think that any one will run the slightest risk in making the experiment. I know that it will answer if made correctly, and therefore rely on its being found a useful improvement.

If you have felt sufficient interest in what I have said to-night, I shall have very great pleasure in explaining it further at another opportunity.

The CHAIRMAN announced that the Council had resolved to appoint a night for the discussion of the subject which Mr. Cole had so chivalrously offered to submit to that test, after the members had had an opportunity of perusing the report in the next number of *The Horological Journal.* Whether it be the elementary portion or the complex portion, the Institute was greatly indebted to Mr. COLE, and ought to pass him a very cordial vote of thanks.

Mr. MURRAY proposed a vote of thanks to Mr. Cole.

Mr. JACKSON, in seconding it, requested Mr. Cole to favour the Institute, for its Museum, with the little instrument he had described as of a similar description.

The resolution having been carried unanimously.

Mr. COLE, in returning thanks, said he acceded to Mr. Jacksou's request; and announced that the work upon the subject upon which he had been engaged for years would soon be published.

ON THE CALCULATION OF TRAINS BY APPROXIMATION.

To the Editor of the Horological Journal.

SIR,—Your last number contained a communication from M. ACHILLE BROCOT, to the Society of Clockmakers in Paris, on "A new mode of calculating trains by approximation," wherein he says, when speaking of continued fractions, that, "their resources are so limited that the results must often be abandoned to go in search of other numbers by chance."

Now in this I do not agree with him, for I cannot find that he has proved anything but what may be accomplished by the ordinary method of continued fractions. Let us take his two examples.

The first fraction is $\frac{191}{23}$. In finding the greatest common measure of $\frac{191}{23}$ the quotients are 8, 3, 3, 2. Therefore the continued fraction is—

$$\frac{191}{23} = 8 + \cfrac{1}{3 + \cfrac{1}{3 + \cfrac{1}{2}}}$$

and the converging fractions are

$$\frac{8}{1}, \frac{25}{3}, \frac{83}{10}, \frac{191}{23}$$

Now by the separate addition or subtraction of the numerators and denominators we have,

$$\frac{25+8}{3+1} = \frac{33}{4}$$

$$\frac{33+25}{4+3} = \frac{58}{7}$$

$$\frac{25+83}{3+10} = \frac{108}{13}$$

$$\frac{25-8}{3-1} = \frac{17}{2}$$

$$\frac{17-8}{2-1} = \frac{9}{1}$$

Which completes the table of M. Brocot; but we may extend it with equal facility:—

$$\frac{108-33}{13-4} = \frac{75}{9}$$

$$\frac{108-17}{13-2} = \frac{91}{11}$$

$$\frac{91+9}{11+1} = \frac{100}{12}$$

and so on as frequently as we please.

Now take the second example; here the fraction is

$$\frac{8796926}{100000} = \frac{4398463}{50000}$$

and the quotients are 87, 1, 31, 1, 1, 7, 1, 1, 2, &c.

$$\therefore \frac{4398463}{50000} = 87 + \cfrac{1}{1 + \cfrac{1}{31 + \cfrac{1}{1 + \cfrac{1}{1 + \cfrac{1}{7 + \cfrac{1}{1 + \cfrac{1}{1 + \&c.}}}}}}}$$

and the converging fractions are—

$$\frac{87}{1}, \frac{88}{1}, \frac{2815}{32}, \frac{2903}{33}, \frac{5718}{65}, \frac{42929}{488}, \frac{48647}{553}, \&c.$$

alternately greater and less than the real value, then:—

$$\frac{2903 + 5718}{33 + 65} = \frac{8621}{98}$$

$$\frac{8621 + 5718}{98 + 65} = \frac{14339}{163}$$

$$\frac{14339 + 5718}{163 + 65} = \frac{20057}{228}$$

$$\frac{20057 + 2903}{228 + 33} = \frac{22960}{261}$$

which completes the second table of M. Brocot, and may be continued as often as we please. Converging fractions give the closet approximation, and the difference of these fractions from the real value may be ascertained by the ordinary method of limits, or by proportion.

In conclusion, I beg leave to say, that I have not written this in any disparagement of M. Brocot's communication, but simply to prove that the results may be as readily gained by continued fractions.

I am, sir, your obedient servant,

74, Cornhill. R. WEBSTER.

THE ASTRONOMER ROYAL ON CHRONOMETERS.

The following has been received by the Admiralty Chronometer Makers, and other members connected with this most important part of horological science.

Admiralty, 4th December, 1860

Sir,—The Lords Commissioners of the Admiralty being desirous of calling the attention of Chronometer makers to the following extract of a Report by the Astronomer Royal on Chronometers offered by them for purchase, and lately on trial at the Royal Observatory, Greenwich, I forward you the same herewith. I am, Sir, your obebient servant, JOHN WASHINGTON.

Hydrographer.

Mr. ——— *Chronometer Maker.*

Extract from the REPORT OF THE ASTRONOMER ROYAL *on the Trial of Chronometers for Purchase, terminated on the* 10*th of November*, 1860.

An examination of the Rates of the Chronometers leads me to the following conclusions :—

(A.) The material and workmanship of all the chronometers is very good; and amongst nearly all the chronometers there is very little difference indeed in this respect. In uniform circumstances of temperature, every one of the chronometers would go almost as well as an astronomical clock.

(B.) The great cause of failure is the want of compensation, or the too great compensation for the effects of temperature.

(C.) Another very serious cause of error is brought out clearly in this trial; namely, fault in the oil, which is injured by heat. This is very different with the chronometers of different makers. For instance: the oil used by one chronometer maker (named in the report) is not at all injured by heat; while some of that used by another chronometer maker (also named) is so bad that, after going through the same heating as those of the first-mentioned maker, the rates of the chronometers are changed (on returning to ordinary temperature) by 80 seconds per week.

(D.) I believe that nearly all the irregularities from week to week, which generally would be interpreted as proving bad workmanship, are in reality due to the two cause (B.) and (C.)

G. B. AIRY,

Astronomer Royal.

COMPENSATION BALANCES.

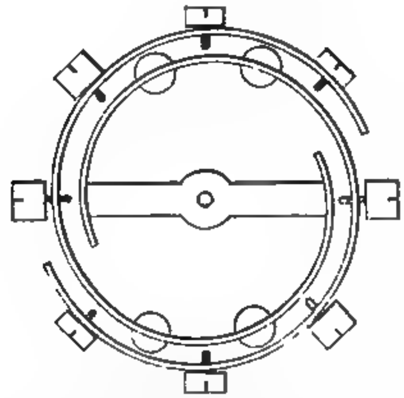
To the Editor of the Horological Journal.

London-street, Kingston-on-Thames, S.W.
December, 1860.

Dear Sir,—Concerning Le Roy's balance being the best for the compensation for middle temperature error:—It certainly would answer that particular purpose, provided it was timed *to it alone;* and so of course will any other balance. But as to its being better than the ordinary balance now in use, I cannot admit, inasmuch as it is but half as efficient, simply because, being cut in the most disadvantageous part of the rim, it follows of course that it has but half the range of the one cut at the side of the arm. And, as the great objection in this latter balance is its rigidity, the same objection prevails in a two-fold degree in Le Roy's, with the short segment, as Le Roy seems to have been aware of by his having employed thermometers to make up the compensation, which he could not obtain by his balance simply.

I look upon Le Roy's balance as a return towards the plain un-cut simple balance, and in itself it certainly is but little better.

But to improve, *perhaps*, this description of balance, I should propose, in order to give more scope and freedom, to prolong the two segments of the rim, carrying them completely round each other, opposite to the ends of the arms from which they spring, in the manner of the following diagram.



The brass being welded on the steel in the ordinary way, a balance so made is easy of construction, and need to be no larger or heavier than the ordinary one now in use. This plan will give it more freedom to meet all extremes of temperature. Probably this plan *may* have been tried, of which I am not aware.

My object is merely to illustrate my meaning in the carrying the two spirals or asymptotes around each other, which of course requires some care as they must be turned up by hand, at least in the bending them around their common centre; whether after that process they might be fixed in a chuck and turned, is a question for those more familiar with eccentric turning than I am. However, after all, it may not be worth the paper spoiled in its description; on the other hand, if nothing were tried we remain for ever *in stato quo*. However, the idea is to me entirely new; nevertheless I think some improvement may be found in it, from its great length of spirals rendering its range and changes with any thermal changes more readily susceptible.

I remain, your's respectfully,

S. LONG.

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

(*Continued from page* 56.)

1842, November 8.—No. 9511.

INGOLD, PIERRE FREDERICK.—"Improvements "in machinery for making parts of watches and "other timekeepers."

[No specification enrolled.]

1843, May 27.—No. 9745.

BAIN, ALEXANDER.—1. Relates to the production and regulation of electric currents.

2. Making the pendulums of electric timepieces keep the same time. Two pendulums of the same length are suspended in the cases; in each case is a permanent magnet. Each has a multiplied coil of wire attached to a spring, which spring has a metallic catch attached to but insulated from it; a similar catch is attached to the pendulum bob. The pendulums will be kept in motion by clocks in the ordinary way. When the pendulums are near the extremity of their vibration to the left, and the catches upon the springs and catches on the bobs are in contact, the electric current is complete, and the coils, being attracted by the magnets, depress the catches, and allow the catches of the pendulum to pass over them. When the pendulums have passed, the current is broken, until upon their return vibration, the faces of the pendulum catches come in contact with the catches of the spring. Should one pendulum arrive at this point before the other, it must remain until the other comes up to it to complete the electric current.

3. Working a pendulum by means of electric currents. The pendulum bob is suspended by a steel spring so as to vibrate slightly between two horseshoe magnets with dissimilar poles facing each other. A small metal ball is fixed to a metal stem on a spindle carried by the pendulum, and is left free to move from side to side. An insulated wire is so connected with the pendulum rod and bob, and the ball stem, that on the vibration of the pendulum to the left, the ball falls to the right, and resting upon a screw completes the electric circuit; the wire round the bob is then repelled by the left-hand magnet, and attracted by the right, until near the extreme end of its vibration to the right, when the ball will fall to the left and thus cut off the current. The principle of attraction and repulsion of the electric conductor is the power applied to the movement of timepieces. An insulated coil of wire is suspended by two springs between two permanent magnets. When the instrument is placed in the electric current, and the current made and broken as aforesaid, this coil vibrates with the pendulum, and by means of a click acts on the teeth of the crown wheel, and catches a tooth every vibration, thus operating as an escapement, or a motion may be given to an escapement in the usual way.

4. Working electric timepieces without breaking the main conducting wire; several sets of instruments being connected to it by secondary conducting wires.

5. Relates to electric printing-telegraphs and signal telegraphs.

[Printed, 3*s*. 5*d*. See Mechanic's Magazine, vol 52, p. 101; and Artizan, vol. 2, pp. 82 and 99.]

1843, June 1.—No. 9752.

INGOLD, PIERRE FREDERICK.—"Improvements "in machinery for making parts of watches, and "other timekeepers."

[No specification enrolled.]

(*To be continued.*)

METEOROLOGICAL OBSERVATIONS,

Taken at 9 A.M., NOVEMBER, 1860.

Gray's Inn Road.

Days of the Month.	Barometer, at 32 F. and mean sea level.	Temperature of air, in shade.	Temperature of evaporation in shade.	Direction of Wind.	Force of Wind
	Inches	°	°		
1	30·109	46	45	NNE	2
2	30·127	45	43	NE	3
3	30·178	40	38	ENE	1
[illegible]	30·154	45	43	SE	3
5	30·161	41	39	ESE	3
6	30·396	44	41	ENE	5
7	30·535	43·5	41·5	NNE	2
8	30·436	42	40	N	3
9	30·346	41	39·5	NNE	1
10	30·120	41	40	E	1
11	29·920	41	39	SE	1
12	29·747	41	40	[illegible]	1
13	29·648	45	43·5	ESE	2
14	29·626	45·7	44·5	W	2
15	29·303	47·5	45·7	WNW	2
16	29·634	41	39	WSW	1
17	29·350	45	43	SW	1
18	29·800	38	35	N	4
19	30·098	39	37·5	W	3
20	30·060	43	41	SW	1
21	29·857	41	39	SSE	2
22	29·508	46	45	W	1
23	29·644	40	39	SE	1
24	29·832	[illegible]	40	NE	1
25	29·580	[illegible]	39	ENE	1
26	29·454	39	38	NE	1
27	29·460	44	43	ENE	2
28	29·700	42·5	41·5	E	2
29	29·874	43	42	E	1
30	29·660	45	44	ESE	1

REMARKS.

From the 20th October to the 10th November, the barometer reading was above 30 inches, the wind being from the eastward, with fine weather for the time of the year.

Nov. 7th, at 10 a.m., bar. 30·540, being the highest reading observed.

14th, at midnight, bar. 29·298, with a furious gale from s.w. and rain.

15th, at 8 a.m., bar. 29·270, being the lowest observed for the month.

17th, at 5 p.m. bar. 29·292, with a strong N.W. wind and much rain.

21st, at midnight, bar. 29·484, with very strong s.w. wind.

R.S.

EQUATION OF TIME TABLE

FOR JANUARY 1861.

Day of the Week	Day of Mnth	At APPARENT NOON — Equation of Time to be *added* to Apparent Time.	Difference for One Hour.	At MEAN NOON — Equation of Time to be *subtracted* from Mean Time.
		m. s.	s.	m. s.
Tues ..	1	3 58·47	1·170	3 58·39
Wed ..	2	4 26·55	1·155	4 26·47
Thurs.	3	4 54·[illegible]	1·140	4 54·19
Fri. ..	[illegible]	5 21·64	1·123	5 21·54
Sat. ..	5	5 48·59	1·105	5 48·49
Sun ...	6	6 15·12	1·086	6 15·01
Mon ..	7	6 41·18	1·065	6 41·06
Tues ..	8	7 6·74	1·043	7 6·61
Wed ..	9	7 31·78	1·020	7 31·65
Thurs..	10	7 56·27	0·996	7 56·14
Fri. ..	11	8 20·[illegible]	0·971	8 20·05
Sat. ..	12	8 43·49	0·945	8 43·35
Sun. ..	13	9 6·17	0·917	9 6·03
Mon ..	14	9 28·19	0·889	9 28·05
Tues ..	15	9 49·53	0·860	9 49·39
Wed ..	16	10 10·[illegible]	0·830	10 10·03
Thurs..	17	10 30·08	0·799	10 29·95
Fri. ..	18	10 49·28	0·768	10 49·14
Sat. ..	19	11 7·72	0·736	11 7·58
Sun. ..	20	11 25·38	0·704	11 25·25
Mon...	21	11 42·27	0·671	11 42·14
Tues ..	22	11 58·37	0·638	11 58·24
Wed ..	23	12 13·68	0·604	12 13·56
Thurs..	24	12 28·18	0·570	12 28·06
Fri. ..	25	12 41·87	0·537	12 41·76
Sat. ..	26	12 54·77	0·503	12 54·66
Sun. ..	27	13 6 [illegible]	0·470	13 6·75
Mon ..	[illegible]	13 18·13	0·436	13 18·03
Tues ..	[illegible]	13 28·59	0·402	13 28·50
Wed ..	30	13 38·24	0·369	13 38·16
Thurs	31	13 47·09	0·335	13 47·02

[illegible] &c.

All [illegible] *this Journal should be ad-* *the Office*, 35, Northampton Sq[illegible]

N.B.—Al[illegible]ts to be inserted in the Journal [illegible]

[illegible] 33, Great Sutton [illegible]
KENT & Co., 51, [illegible]

BRITISH HOROLOGICAL INSTITUTE.

DISCUSSION ON THE PAPER READ BY MR. J. F. COLE, ON HIS DIAGRAMS OF THE LEVER ESCAPEMENT.

At the Discussion Meeting on the 8th January, 1861, the Chairman, Mr. W. B. CRISP, briefly addressed the Members, and explained that at the close of Mr. Cole's Reading (December 11th, 1860), the Question was asked, "*How the place of the Pallet Centre was determined?*" He now, perhaps, would kindly answer that question. Mr. COLE replied,—

Mr. Chairman, In order to render what I shall say upon this question more clearly understood, I have drawn upon the black board an enlarged diagram shewing the mechanical and geometrical principle adopted by me for determining what I consider to be the correct mechanical position of the centre of motion of lever pallets, relatively to the centre of motion and diameter of the escape wheel.

The wheel in this diagram represents the lever escapement wheel of 15 teeth, as the number usually employed, but whether for this or any other number, for wheels of any required diameter, or for pallets embracing three or more teeth of the respective wheel, the rectangular principle I shall now describe for determining the proper mechanical place of the pallet centre of motion, will apply correctly in all cases either for pallets of lever watches, or for the Graham dead-beat pallets of astronomical clocks.

In submitting the observations I shall make this evening, I do not offer the rectangular method shewn in this diagram as an arbitary rule, further than as relates to fixing the centre of the pallets at a place where the wheel teeth will rest alternately on both the inner and outer lockings, in a manner which will allow the wheel force to be impressed upon both the lockings, in a truly tangental direction, equally to and from the pallet centre, and also to secure equality of hold and uniform resistance on both the lockings; these are points of principle which properly should be preserved, and that they exist under the arrangement in this diagram, is evident by the radial distance of each locking of the pallets traversing the same circle.

The advantage of equal resistance at the lockings cannot be made available without departing from the customary mode of forming lever pallets; in such, the place of the centre is usually midway between the locking corner of the first pallet and the delivery point of the second pallet, and when so, the pallet centre would naturally stand opposite or nearly so, to the point of the middle tooth of the three, enclosed within the pallets, and a circle drawn from such ordinary centre, would of course cut the outer first and last acting extremities just mentioned, both which in this case, would travel at an equal rate; pallets made in this, the ordinary manner, have the two arms of equal radial length, and are said to be made "in circle;" contrary to this, the first-mentioned pallets (as shewn in the diagram), have radial arms of unequal length, and it may be objected that such inequality of length would render the effective force of the wheel, in giving impulse on the roller and balance, unequal also; this view I consider erroneous.

Touching the point just named (the effective force by pallet arms of unequal length), I think the common axiom of power being gained by the longer lever, though true in reference to simple leverage, is by no means true under the complex connexion with diagonal planes of impulse, though on the longer arm.

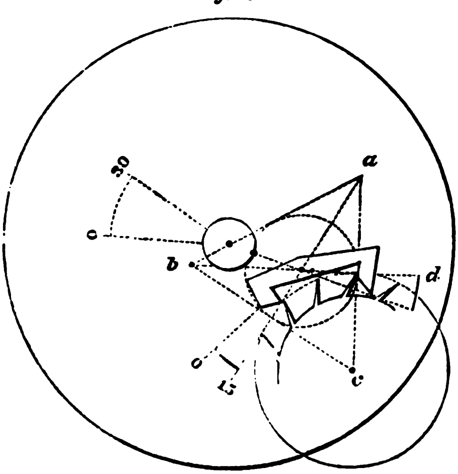
In discussing this property of leverage by pallet arms of unequal length, it cannot be admitted that the ordinary trade pallets with arms of equal length, are free from what may perhaps by some be called "the defect," as the wheel teeth in passing over the first pallet plane of impulse shortens the leverage, and in passing over the second pallet plane the leverage is lengthened.

Under these conditions of the two kinds of pallets, should it be asked what amount of advantage is due to arms of equal length, and consequently unequal lockings, over pallets with arms of unequal length and equal lockings, my answer would be, that if the acting face of the first pallet impulse plane, in either case, be made of a convex form, so that on both sides a like arc of pallet motion be produced, like effects of power would result, whether made in the one or the other manner; the greater disadvantage (if it be one) is the quicker action at the delivery point of the longer pallet at the moment of closing at the backs of the teeth.

I must here observe, that by the varying effects of power on the planes of the first and second pallet in the course of action, the angularity and resistance of the first goes on increasing and that of the second decreasing, and hence the propriety, in either case, of giving to the first pallet acting face a convex or epicycloidal form, but this is more especially necessary in the case of long arc pallets.

I will now explain what I have spoken of as the rectangular method of determining the true mechanical place of the pallet centre; this is done by laying down on paper or on a metal plate, a circle of any diameter, representing the intended lever escapement wheel, of any number decided on, and in this diagram the ordinary number 15 is adopted, though any other number would do equally well for the purpose; the circle

Fig. 1.



being correctly divided into 15 equal parts; draw from the wheel centre *c*, a radial line passing exactly through one of the division points, each representing the point of a tooth, and the line extending to the point *a*, an equal distance outside the circumference of the circle.

Before proceeding further, the number of teeth to be scaped over by the pallets must be determined. Three teeth being the customary number included within the pallets, I have used that number here; the pallets therefore embrace three teeth and two spaces, reckoning the teeth and spaces backwardly from the first radial line and point, as the place of the inner or second pallet locking, the third space therefrom must be divided by a point placed exactly midway between the locking extremities of the two teeth forming that interval, and through this subdividing point (now the place of the first pallet locking) draw a second radial line from the wheel centre *c*, to the point *b*, equidistant as before, beyond the circumference of the wheel circle.

It will be observed that the wheel centre, and the two points *a*, and *b*, (in reference only to 15 toothed wheels) form an equilateral triangle, the wheel being 15, is divided again by the alternate action of the pallets into 30 equal parts, giving that number of impulses in each revolution; five of these parts =60 degrees, are contained within the two radial lines forming two sides of the triangle, which multiplied by 6, completes the circle, and serves to shew, as will be seen, how naturally this geometrical figure is found to harmonize with all points essential to the true development of the principles of this particular class of escapement when 15 toothed wheels are employed.

From the locking point on the first radial line *c*, *a*, draw another line to *b*, the opposite apex of the triangle, thus forming a true perpendicular to the radius *c*, *a*, as a tangent to the wheel circle, and from the locking point on the second radial line *c*, *b*, draw another line to *a*, the second apex of the triangle, as a perpendicular to the radial line *c*, *b*, also a tangent to the wheel, and at the point where the two perpendiculars intersect each other will be the true rectangular place of the pallet centre of motion; the triangle therefore being the simplest means of producing the tangent, explains my motive in using it.

After these remarks I think it will be evident, that any change from the mechanically proper position of the pallet centre, thus determined, can only be productive of defects at the lockings; these consist in diverting the rectangular direction of the wheel-force, which may be preserved on the inner locking, by allowing the whole defect to fall elsewhere, as it would do by moving the centre forward on the line *b*, *d*, to a position equidistant between the outer locking corner and the delivery point of the second pallet, thus preserving the tangental bearing of the wheel tooth on the second or inner locking; by this displacement of the centre, the whole defect is thrown on the first or outer pallet locking.

In illustration of this, I find, on careful measurement of a correctly-made drawing of the wheel and pallets on a large scale, that the proper geometrical distance of the pallet centre beyond the periphery of the wheel circle, is exactly one-fifth part of the chord of five teeth from point to point, and, as pallets are usually made, the distance or pitch of the centre is sometimes less; admitting this, the ultimate effect of the draw will

be sufficiently correct, provided the locking angle of the first pallet be made stronger to suit the altered position of the centre on the line *b*, *d*, as stated by me at the time this question was raised, and as evidenced by the effective action of well-made pallets generally employed in the manufacture of lever watches.

Mr. J. L. Tilling said, he should like to know why Mr. Cole deviates from the principle of short angles, a principle which no one else has done so much to bring into use, and which he evidently still believes to have the superiority, by his adoption of it to his resilient lever. Mr. Cole now places before us the long arc pallets, as shewn in his diagram illustrative of the mode of determining the position of the hole, in a way, that he tells us, is the only geometrical rule for defining the position of the hole. This I can prove is wrong, by a diagram of a wheel and pallet which I have here.

Mr. Cole's illustration of Mudge's Lever Escapement, now hanging in the Musuem, contains the great improvement of the reduction of the angles of the pallets (both circular pallets). He stated in his late Reading, in reference to Diagram No. 3, that a circular pallet with the impulse plane of the straight pallet in a line with the delivery point of the crook, constituted a twelve-degree pallet, and such could not be obtained by any other means, unless by improperly pitching too deep; yet I will undertake to say that a pallet made to the same measurement would prove to be nearer fourteen degrees, if tried in a tool which I have for the purpose, an angle indicator. The drawing on the board represents a pallet with the line of impulse considerably below the delivery point of the crook, as a fifteen-degree pallet: rather a strange contradiction. Mr. Cole remarked, as a singular fact, that the measurement of the crook counts 24 for 12 degrees actual angle; but if the pallets are made circular and the measurement is taken from the right angle of the hole and circumference of the wheel, as shown in my diagram, the singular fact will disappear. Mr. Cole remarked, that it is surprising how well lever watches will sometimes perform on such opposite principles. But the question is how long do they continue to perform well when they are dirty? The relative value of 15 degrees is, taking 2 degrees for the locking leaves, 13 *degrees actual friction* on the impulse planes, while with the same deduction from the 8 degree pallets, there is only 6 *degrees actual friction* on the planes of the pallet. I will leave practical men to give their opinion as to where the advantage is, in the long or the short arc. Most escapements have a fixed principle to depend upon, but in the lever there is none. I have had some experience in lever escapements, having been engaged in their manufacture all my life; and may be entitled to hazard an opinion, and it is, that *the whole mystery lies in the reduction of the pallet angle.* I will give an illustration, of which, I think, the gentlemen present will see the force. Is it not universally known that Mr. Swift has for a long period been the best pallet maker in the entire trade? Escapements made with his pallets are known to give better results than with those of most other makers. If the superior workmanship was the only item they could not, surely, have maintained their character for excellence, for we have many skilful workmen in the pallet trade. Their superiority consists in being circular pallets, or nearly so, the hole being nearer to the crook if any thing, really producing a short angle pallet. His half-angle pallet not being over 10 or 11 degrees, yet the line of the impulse plane measures the same as Mr. Cole's 15 degree pallet.

I will now make a few remarks on the properties of the resilient lever. Mr. Cole attributes superior timeing capabilities to the resilient principle. So far from that being the case, I think I can convince you, gentlemen, that the resilient wheel is rather detrimental to the continuance of good time, from the simple fact of its being a club wheel, which produces considerably more friction than the ordinary wheel. Also, the plane of the tooth and the plane of the pallet being parallel, the thickening of the oil will cause a suction that must ultimately affect the time, independently of the same action in the locking corners. The resilient lever was intended to abolish the banking and guard pins; a very desirable thing, because a great deal of trouble is experienced in timeing in positions arising from the want of freedom, caused by too close a banking, imperfect draw on the pallet, or too wide a pallet hole, all which may escape the springer's obsevation. From Mr. Cole's late Reading, I find that he adopts the guard as a permanent item of the resilient lever, yet cannot do so without adopting the double roller principle. I have no doubt that the guard pin was a sad trouble to the inventor. He could not do with it on the single roller, because he could not get freedom. Neither could he do without it, because it would trip when agitated to test the resilient principle. To remedy these evils he had to create another evil by under-cutting the locking planes; thus increasing the locking resistance. But, by adopting the 8 degree pallet, its superior action overcomes all defects—

locking resistance, club wheel, thickening of the oil, &c.—and really produces, as Mr. Cole informed you, the best pocket timekeeper. I am prepared to say, that if the resilient wheel were taken off the pinion and a club wheel of Glashan's pattern put on (which I consider is the best form of club wheel) and the lever banked, there would be no perceptible difference in the rate, unless agitated purposely to make it strike the banking, a treatment the resilient will stand without acceleration of time, but rather a dangerous experiment to apply to a pendulum spring.

Some years since, finding a great difference in the results from my escapements, I tried various experiments to arrive at a certain mode of measuring the various parts of the escapement, which led to many curious discoveries. One discovery I soon made, and it was, that trying experiments did not contribute to enrich the pocket. The ultimate result, however, was *a perfect lever-escapement sector*, which not only gave the sizes, but having ascertained the actual angle by the indicator, supposing it to be 10°, by setting the sector at 10, and requiring the escapement to be 30 degrees of the balance, by setting it at that number, it will mark the position of the pin hole in the roller, will give the position of the balance and pallet arbor holes, and secure the angle of result from the smallest size to the largest clock escapement.

Fig. 2.

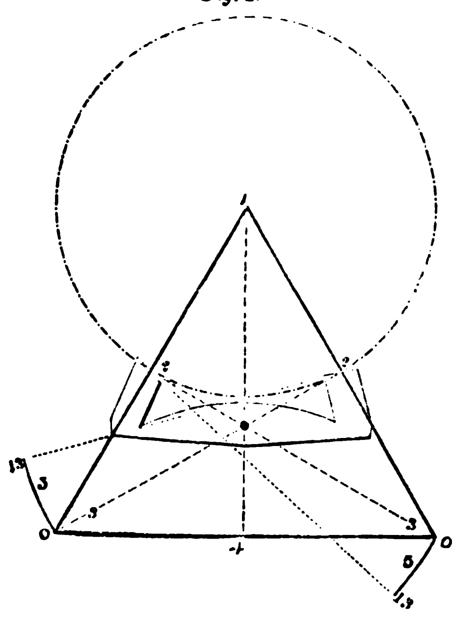


Fig. 2 represents a subdivided triangle, its length being the diameter of the wheel, showing all the points of action and lines of measurement in the wheel and pallet, and its planes being the centre of the wheel. A circle drawn intersecting the triangle at 2,2, gives the size of the wheel, and the centre of the pallet planes or place of rest when the power is applied to the escapement; a line through those centres to 3,3, gives the line of O, from which to measure the angle of impulse. If the hole was planted on the line from 1 to 4, where the lines intersect, it would give an equal measurement on the index at each swing of the pallet, as shown at 5,5, but the practice is to get the hole much nearer to the wheel, and doing so gives a safer locking and more perfect draw without increasing the locking resistance, but causing the apparent difference in the measure of the angles mentioned by Mr. Cole, and illustrated in his Diagram No. 3.

Mr. J. F. Cole explained that his diagram was also made to shew the proper arrangements and proportions suitable to long arc pallets of 15 degrees, as fully described in the preceding number (29) of the Journal, at page 65, where all the essential points of Mr. Tilling's objections, and of Mr. Cole's reply were published prior to the Discussion. He had no object in treating the subject of long arc pallets other than by way of contrast, to shew the comparative difference of the long and short-arc principles, and the respective properties of each, as clearly stated by him in *The Horological Journal* just referred to; pages 65 and 66 contain his observations in reply to Remarks on his Resilient Lever Escapement.

Mr. Storer observed, I have no particular objection to the views advanced by Mr. Cole. His motive for introducing the Diagrams before us must be evident; he having been requested to define the correct position for the centre of pallets he determines it geometrically. I remember having once made three escapements with pallets of the construction here given and found no "set" upon the planes of the pallets. The proportions for the lever and roller were a chord of five teeth divided by three.

The gold pin escapement is one of an ingenious construction, light in action, and very durable if well made. It is, however, open to objection, owing to its liability to bank, through the necessarily great width of the lever fork occupying so much space on each side of the line of centres.

I make these few remarks in order to elicit the opinion of Mr. Cole regarding this escapement.

Mr. Cole, in reply observed, another question arose as to the merits of Three-Pinned Lever Escapements. His answer was, that

this principle of action was much more critical, and afforded no advantage over the flatted ruby pin action, it would be much improved if the lower side of the impulse roller was turned hollow, for forming a rim at the full diameter of the roller, the greater portion of which being removed, would leave a solid projecting part below the surface, answering a far better purpose than the two pins inserted in the roller, by reason of the discharge action, produced in this manner moving at the same rate with the bent-over guard pin in the lever; in this mode, the notch is cut through the solid projection and roller edge; the nearest resemblance to this amendment was the plan adopted by Mr. Hutton. After all, he considered the double roller action with flatted ruby pin, superior for soundness of detention to any other modification of the lever and roller action.

Mr. Marshall enquired respecting Mr. Cole's simplified chronometer locking spring; his reply was, that he had found it to answer well, and, if properly made and applied, he had no doubt it would be found entirely satisfactory to others adopting the principle, which, as seen by the engraving in the Journal, is designed for reverse-train movements or marine chronometers, where the frame plate is entire for placing the banking pin as there described, but can as easily be adapted to movements of any other construction.

Mr. Tilling wished to say a few words respecting the Two-Pin Lever Escapement. It may be urged that the two-pin lever is made with long arc pallets, and yet has always been considered the best of lever escapements since George Savage made them; but he and his brother made pallets in circle, and anybody who has studied this escapement must know that the excessive resistance on the impulse plane is greatly reduced by the pin in the lever acting on the extreme edge of the roller, while the locking resistance is overcome by the pins in the roller being so much nearer the centre of action, and in reality becoming a short angle escapement. I think its occasional failure arises from the practice of having an excess of angle on the pallet, it averaging 15 degrees. By taking two degrees to unlock the pallet, the escapement being made at 30 degrees, the impulse pin is thrown on the edge of the roller when the roller notch has only advanced toward the line of centres 4 degrees out of 15, the pin not having entered sufficiently into the notch to give it a safe depth, causing it to butt on the corner the same as a wheel depth butts when the pinion is too large for the wheel. While the 10 degrees, or corner angle pallet, made in circle, I will endeavour to shew, is the best form of pallet for the two-pin escapement. Taking 2 degrees from 10, for unlocking a 30 degree escapement, the notch will be able to advance towards the line of centres 6 degrees in 15, so giving a safe depth to the impulse pin before it commences to propel the balance, at the same time giving a free action resembling a wheel and pinion sized correctly. I will only further add, that some of the most successful timekeepers, to which I have made escapements, were on the two-pin principle with short arc pallets, substituting the angular stone for the two pins in the roller, but Mr. Hutton's jewelled escapement if made at 30 degrees with the short arc pallet, is, I think, the best kind of escapement on the two-pin principle.

Mr. Jackson said, in the presence of so much detailed information, which they had obtained from the Reading of the paper by Mr. Cole, as well as from this Discussion, he did not presume to critisize; but felt an obligation to express a lively sense of gratitude to that gentleman for these observations, which were of the most valuable practical character; especially for the clear and exact details and illustrations of the principles and proportions of the lever escapement, which had been demonstrated at such length and with so much trouble.

He hoped this liberal example might have imitators in other departments; and that they might benefit by practical observations and the details of experience of a like useful character. His experience, and doubtless the experience of many others, was, that after the usual term of apprenticeship in the acquirement of the proper amount of skill in the working of an escapement, which he was enabled to do by the use of fixed gauges for diameters, arcs, &c., described on brass, he was so dependant upon these gauges, that in their absence he would have been at a loss to define the proper lengths and proportions. The simple rules for arriving at these, now laid before them, were however so plain and obvious that no young man in future need be ignorant of his art in this respect.

He had prepared a small tool for their Museum, by the use of which any pallet might be tested, and the number of degrees of its angle described, and also the result (the balance arc of escapement) easily read off. By the use of this for an ordinary lever escapement, the lever and roller might be supplied with the pallets, leaving the escapement maker to finish and plant them, thereby economizing both time and money.

Thanks were voted to the Chairman and the meeting separated.

[In conexion with the above Discussion, we have received the following Diagram and explanation from Mr. Tilling.—Ed. H. J.]

Fig. 3.

Fig. 3 explains the difference in the measure of the angle; being a sketch of a wheel and pallet of 8 degrees, having that amount of dip into the wheel at each drop of the tooth, including the locking quantity indicated at A, A. If a line is drawn from the centre of the planes through the pallet hole to B B, the pallet hole being nearer to the wheel than the centre of the triangle gives a line of divergance of 3 degrees from the right angle, apparently reducing the straight to 10 degrees, but adding the 3 degrees to the measurement of the crook pallet making it appear 16; the lines C, C, are the lines of the impulse planes, and from that line to the corner of the triangle gives 13 degrees on each, but from B to C (which is Mr. Cole's measure ment) gives 10 on the straight but 16 on the crook pallet for 8 degrees actual angle on the pallet. When the hole is out of the centre it varies the angle much more, but the true point of measurement is shown at A, A, being the angle of result.

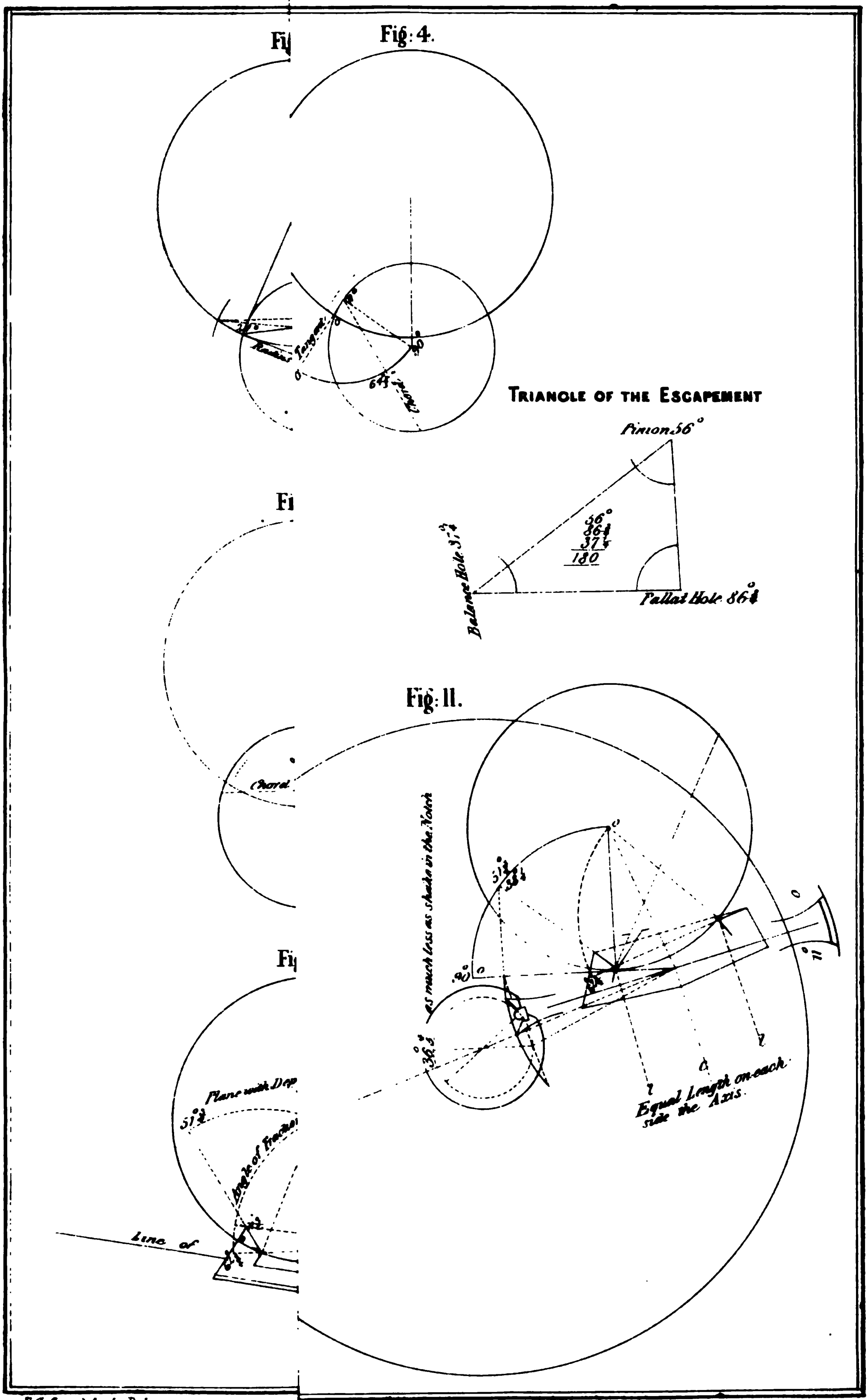
ON THE LEVER ESCAPEMENT; AND THE FORMATION OF PALLET ANGLES.

By Thomas Charles Scotchford.

(With a separate Sheet of Illustrative Diagrams.)

In making pallets, the angle and thickness of the wheel-teeth are of primary importance, so that the wheel may go through the greatest angle of sliding; for the greater distance the wheel arcs over the plane, the greater motion will the pallets make. If on any size of pallets one wheel is applied of a finer tooth than another one, those pallets that have the finest tooth will make the greatest arc of motion, at the same angle or form of the planes. Also, if the forms of the teeth of the wheel vary, as regards the angle of the teeth, it will be impossible to gain the same form of the locking-plane on *both* of the pallets' lockings; although one locking may be improved, yet the other will have to be made to suit the form of the tooth, if both locking-planes are made to run up as nearly as possible with equal speed. *Obtuse forms of the wheel teeth* diminish the length of the planes, whereby the wheel does not slide through so great an angle, consequently there is not quite so much motion made by the plane. [The lockings are of the utmost importance in timeing; for the greater distance the pallet enters the wheel, the greater distance will the wheel have to be moved back by the balance in unlocking.] Where the long pallet is much cut under, whether the depth is planted deep or shallow, if the roller depth necessitates the pallet going deep in the wheel—those pallet-lockings will be so hard they will be found the worst faults in the watch. It would be an easy matter to make good lockings with any wheel; but the planes would offer an unequal opposition to the impulse.

The planes of pallets are plane superfices, and with their locking-planes they form angles. They are portions of two chords round which a circle may be described. The circle described, they form chords of segments which measured is found some inclination, which is equal to an angle in the alternate segments. It is not in the numbers of these angles to which any property pertains. It is the *forms* of the planes that are required, which forms when in contact with the wheel (or the direction of the power) produce certain oppositions to that power forming angles of traction,—that is, the drawing angle of the wheel tracks upon the plane. These vary



T.C. Scotchford. Del.

Maclure, Macdonald & Macgregor, Lith^rs London.

every instant with the sliding on the long pallet. But the forms of these planes produce the nearest to a perfect required action on both planes that can be produced to a 15 toothed wheel, engaging three or four teeth alternately. The property is:—The difference in the two angles of the traction between the two pallets is equal to the angle the wheel goes through in its sliding (10°) over the plane of the leading pallet in its coming towards the centre, the resistance to the power being the same when it approaches the centre as when it recedes from the centre. In approaching towards the centre the angle of the short pallet plane is a *constant angle*, if the plane makes the same motion as the wheel arcs over it of 10°, it is only $1\frac{1}{2}$° less when the plane makes $8\frac{1}{2}$° of motion, and it may be made of a form more *acute*, so as to form a *hard wedge* with the wheel as it nears the end of the plane. The long pallet is at its greatest angle at the commencement, and that angle gets less as the wheel passes over it, and although it might easily be set on the long pallet, yet it will be found that the angle upon it is too great for the length of the lever applied.

Every escapement wheel is of the least power the greater the distance on its arc at which it acts from the centre; the arm of the pallet is then at its greatest power. Every wheel is at its greatest power the nearer on its arc it acts to the centre. At this position the arm of the pallet is shorter and of less power. They thus always perfectly equalize themselves if the pallets are placed at an equal altitude upon the lever on both sides. The requirement is the angles which their planes will form with the wheel. A lever could be found to a plane of any inclination. The greater the inclination the shorter will the lever become; the less the inclination the longer will be the lever. The lever can thus always be made to the escapement wheel, and the inclination of any one plane. But it *cannot* be made so for both of the planes to be equal to that with the wheel sliding through an angle over them, the long pallet being the plane proper and the short pallet an interior and constant angle, in its opposition as a plane. As a *plane angle* some lever might be sized to it under *certain circumstance of the amount of angle*, but a lever could not be sized to it as a *true fixed law*. The manner in which the long pallet plane is taken as it stands upon the lever and drawn into the cosine of the angle to the radius of the wheel, the interior angle on the short pallet being *depressed* sufficiently to admit of a difference between the two planes *of the amount the wheel slides over it;* thus forming at the *limit* some angle by which to *estimate* the *roller* according to the size of the *balance*.

This angle at the limit has nothing to do with the whole arc of the balance, including a depth. It is the arc of impulse, and it is shown on the diagram, that an angle at the centre of this balance of $2\frac{3}{10}$ times the size of the wheel of $27\frac{1}{4}$° is equal to an angle at the centre of the wheel of $62\frac{3}{4}$°, as by multiplying the arc of $27\frac{1}{4}$° of impulse by the size of the balance $2\frac{3}{10}$ is the same as the size of the wheel which is being opposed by a plane, which plane forms with the wheel an angle equal to $62\frac{3}{4}$ at the centre of such wheel. Also the size of this balance is equal to the size in length of the whole three radii of roller, lever, and wheel. In impulse the lever is of the third class, in unlocking it is of the second class, alternately, but distinctly of these orders.

Figures 1, 2, and 3, exhibit the angles and chords of an escape-wheel with 15 teeth, to engage alternately 3 and 4 teeth.

Fig. 1, shews the chords of the wheel subtended by the action of 3 and 4 teeth alternately. The lockings are always 60° apart, and the line of bisection is on one side of the *Hole* 6°, equal to half the 12° which the wheel goes through at each drop. The hole divides them into two angles of 24° and 36° respectively.

Fig. 2, A is the long pallet side.

The wheel will arc through $9\frac{1}{4}$° of sliding over the plane. B is the short pallet side. The wheel will arc through 10° of sliding over the plane.

The thickness of the point of a tooth should be 1° full, not more; and the angle of tooth from 64° to 66°.

Fig. 3, The principle upon which pallets draw in to the wheel is that of the inclined plane. The locking planes are at some angle, which angle may be the same, although the *form* of the plane is *very different*. It depends upon the position of the pallet hole. From this hole to the locking corners are oblique radii, and if the planes are at right angles to the oblique radii, there will be a dead pull and no motion. Should the plane pass into the wheel at a depth on the long pallet then the same form of plane will draw in if it has attained an inclination, but on the short pallet it would be worse, for it never could attain an acute angle. For pallets to draw inward to the wheel, the long pallet-locking must be an obtuse angle with the oblique radii, and the short pallet must be an acute angle with the oblique radii. Should the forms of the planes make the angles the reverse of this—that is, long pallet *acute*, and the short pallet *obtuse*,—then the motion would be outward instead of inward, but properly they

would then require a tooth of the wheel reserved. These are the *minimum* angles at which they will detach the pin from the edge with as near equal speed as possible, and this is the *straightest* form of tooth suitable for them. Pallets will draw, with scarce any perceptible difference, with a tooth of 2 or 3 degrees less angle, but if it is any straighter it will not draw easily upon the plane. The plane will have to be more undercut to draw at all, and it will rub the plane hard. Should the angle be *much less*, then it will not draw in on the short pallet until the locking-plane is made more acute to suit it. The opening at *a* in the wheel, and at *a* on the pallet shew the principle. If these openings are equal, the pallet will draw in until it attains a right angle. Whatever the wheel goes forward by the pallet drawing inward, will have to be recoiled back again.

The depth on the roller is highly important in connection with the form of these pallet-lockings, for as the pallet goes up in the wheel, it cuts itself under, and the wheel goes forward upon it. It must all be recoiled back again in unlocking.

For pallets to be of precisely the same form of both impulse and locking planes they must all form similar triangles. But where the hole can be got sound as in large sizes, the impact is stronger, and the long pallet locking straighter when the hole is closer to the wheel.

Figures 4, 5, 6, 7, 8 and 9, exhibit the angles formed by the planes as portions of chords of segments, and as inscribed angles in the wheel, also the angles formed by the direction of the power with the sloping surfaces of the planes; and the radius of the wheel drawn into its cosine of the angle of the direction of the pressure with the direction of the acting power (the radius of the wheel).

The difference between the angle of traction (56¾°) at the commencement of the action on the long pallet, and the angle of traction (64¾°) at the discharging end of the short pallet, is 8°, equal to the arc of the plane when they are *without* their depths. The difference between them when in the wheel *at their depths* is 11° The plane will make 8½° and the depth is 3°, or 11½° of motion from drop to drop, and this gives 11° of difference in the angles of the track of the wheel over the plane.

Fig. 4 gives the measurement of the long pallet or inclined plane proper to which the lever is made.

Fig. 5, gives the measurement of the short pallet or leader.

Fig. 6, gives the chord, or base, of the inscribed angle at the circumference of the wheel at the meeting of the power and the plane.

Fig. 7, shews the position of the pallets on the lever, which bring the pallet hole 3¼° less then a right angle when *in centre*, and the centre of gravity falls in the pallet-hole. A, the chord of the wheel, parallel to B, the lever, or diameter of the circle.

Fig. 8, developes the angles between the direction of the power and the sloping surface of the long pallet. At the limit the angle is 62¾°, at the begining 51¾°, being a difference of 11°. The angle the wheel arcs over is 10°, there is therefore 1° to spare.

N.B. The pallets have 8½° of arc by the plane, not 8° only. The arc of motion from drop to drop is 11½°. The plane is 8½° and the depth is 3°. The thickness of the tooth point of a wheel 1⅛°. The inclination or angle of tooth 66° to 64°. There will be small variations both in pallets and wheel.

Fig. 9, Every wheel loses power according to the inclination of the plane which opposes it; that is, according to the obliquity of the power from the direction of pressure. The effective power is only equal to the cosine of the full-size radius.

Fig. 10, exhibits how to find a lever to any one inclined plane and given radius of wheel. Take the wheel, and planting the compasses in the foot of the plane, describe a quadrant; let fall a perpendicular (sine) and you have the lever to that wheel and that angle.

It is not any particular matter whether a quadrant be made or not, so that the lever is the base of the plane, only it does form a quadrant. The proper length of lever is as the cosine of the angle on the plane to the radius of the escapement-wheel. In the impact the force of the blow will be less effective on the short pallet plane. In an impulse, by it acting obliquely, the force must be resolved as part of the force is in the vertical direction *a*, *a'*, and part in the horizontal direction *a'*, *c*. The horizontal length is the only effective part of the power, the vertical part is useless; whereby there are unequal lengths on each side of the axis.

Fig. 11, exhibits the same pallets on the lever between a parallel chord and a diameter (See *fig.* 7) lever, which brings the lengths equal on each side of the pallet axis, in the horizontal line of the lever. By the power acting upon the plane bent up upon the lever, it is the same as the lever being lowered down from the plane through some angle. By letting fall the perpendicular upon it the lever is again the correct length, but as much shorter as the space at *s* in *fig.* 10.

Arc of impulse of escapement 27¼°
By unlocking................ 9⅜
Total.........36⅝, or $36\frac{11}{16}$
Arc of impulse.............. 27¼
Balance..................... $2\frac{3}{10}$
Angle at limit............... 62⅝

Nothing more can be done than to *estimate* the balance according to the angles of the pallets. The *mechanism* is not the *motion*.

The lever is the chord of 69½° of the escapement-wheel, and the roller crank goes 3¼ times lineally in the lever chord of 21° from the centre of balance staff to centre of ruby pin.

The roller always multiplies the arc of the lever into the angle of the balance. The size of the balance is estimated according to the angle at the *limit* that the plane of the pallet forms with the radius of the wheel. The angle at the limit is 62⅝° and the balance is $2\frac{3}{10}$ times the size of the escape-wheel. The reason for taking this *estimate* is, that by these sizes and angles the escapement is made to the size of the balance. For if the length of the cosine of the angle be taken, as at *fig.* 9, (which cosine is the only effective length of the radius of the wheel through its acting upon a plane at the angle or inclination) and this length be added to the lever and roller it will complete the radius of the balance. Otherwise, the larger the balance the greater will be the momentum in proportion to a small one, with any given weight and velocity. The roller depth is sure at this arc, on a small escapement. The escapement ends at the lever.

The angle of traction at the limit is 62⅝° and at the commencement 51⅝. The difference between them is 11°, and as the wheel will only slide through 10° there is 1° to spare.

When pallets are made upon the principle herein expounded, to make 10° of motion by the plane without the depth, the two planes intersect right dead through the centre of the long pallet face, and the angle of the inserted plane of the short pallet is the same at the discharging end of the plane as it is at the begining of the same plane; this is the point at which motion ought to cease to be made by them.

Soldering Metals with Tin.—Put one pint of muriatic acid into an earthern pot that will hold at least one quart; into this drop small pieces of zinc until it will dissolve no more; then add half an ounce of muriate of ammonia, and boil the whole about three minutes. Apply some of this solution to the part that is wanted soldered, when the tin will plane freely.

METEOROLOGICAL OBSERVATIONS,

Taken at 9 a.m., December, 1860.

Gray's Inn Road.

					State of the Weather.
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			NNE	3	
			WNW	0	
[illegible]	[illegible]		W	0	
20	29·766	27	N	3	
21	29·929	31	N	3	
22	29·862	31	NNW		m, b
23	29·754	28	NW		m, b
24	29·468	27·5	WSW		m, f f
25	29·497	13	N		m, b
26	29·560	26·7	NNE		f, b, s
27	29·490	32·4	N		m, ss
28	29·878	29	N		m, f
29	30·407	18·5	E		bm, rs
30	29 545	38	WSW		m
31	29·654	36·7	W		o, r r

Remarks.

The letters for the weather signify:—b, blue sky (clear); c, detached clouds; f, fog; m, mist or haze; o, overcast or dull; r, rain; s, snow; and a letter repeated increases, as rr, much rain; mm, dense mist. Thus the letters for the 1st Dec. signify that at 9 a.m. the atmosphere was clear, the sky being blue with detached clouds, afterwards it became overcast, then there was rain, followed by blue sky and detached clouds. As another example: on the 19th there was a dense fog at 9 a.m., which passed into ordinary fog, and then haze with blue sky and clouds during the day.

From the 1st to the 9th, there was a continual fall in the barometer, while the comparison of the temperatures of the dry and wet thermometers shows that there was abundance of moisture in the air. The fall in the barometer is indicative of change of wind, or rain; but when the thermometers

indicate moisture, rain is more propable. It will be remarked that there was no marked change in the wind, it being south-easterly during these days; but there was more or less rain on each day.

On the 6th, about 6 p.m., a heavy gale blew from S.S.W. for about two hours, when the wind became almost calm: bar. 29·240.

On the 7th, from 7 p.m. till past midnight, there was a strong gale from S.S.W. and S.W.

Barometer at 3 p.m.	29·112	wind	S.	force	2
,, 7	,,	29·054	,,	S.S.W.	,,	6
,, 10	,,	29·018	,,	S.W.	,,	8

The barometer continued to fall till 5 p.m. of the 8th when it was 28·780, wind S.E. light;—having had much rain during the day.

From the 9th to 15th the barometer rapidly rose; and moisture though great was less: indicative of a change of wind to the northward. During these days we had northerly winds, and no rain or snow; that is to say we had fair weather for the month. But observe, this weather was of short duration, which is generally the case when the *rise* in the barometer is sudden (and the same holds good for a rapid *fall*).

For the fall in the barometer between the 16th and 19th we had rain, while the wind remained north-westerly.

A remarkable fall in the thermometer took place on the 18th; and one still more remarkable on the 25th. The average London temperature for December is 39 deg. Since the 18th, it has been much below this average, and therefore so much more severe than in ordinary years. The barometer has been very unsteady, and at times low. The wind however has been chiefly from northward. We see the cause of the low and unsteady barometer, in the many changes from thick fog to mist and haze, from snow to overcast and clear.

On 27th, at 11 p.m., bar. was 29·537, wind E., force 6; and during the night much snow fell.

On 29th at 10 a.m., bar. was 30·420, after which it fell; and at 11 p.m. was 30·075, wind S.E., force 6, followed by snow and rain. On the morning of 30th a thaw set in, rendering the streets exceedingly sloppy and dirty.

R.S.

Errata in Mr. COLE'S "READING," in No. 29.

Page 63, line 9 from top, *read* "acceleration of rate."
Page 64, line 34, *read* "12 degrees at the pallets."
Page 64, lines 42 and 43, *read* "when the lever and roller are suitably proportioned."
Page 66, line 16, *read* "as the angle *and* arc of motion is greater or less."
Page 66, line 23, *read* "and by creating *greater* friction,"
Page 67, line 32, *read* "the little instrument he had described for testing pallet angles."

Page 69, line 21, "*in stato quo*," should be "*in statu quo*."

EQUATION OF TIME TABLE

For February 1861.

Day of the Week.	Day of Mnth.	At Apparent Noon — Equation of Time to be *added* to Apparent Time.	Difference for One Hour.	At Mean Noon — Equation of Time to be *subtracted* from Mean Time.
		m. s.	s.	m. s.
Fri. ..	1	13 55·13	0·302	13 55·06
Sat. ..	2	14 2·37	0·268	14 2·31
Sun...	3	14 8·80	0·235	14 8·74
Mon ..	4	14 14·44	0·201	14 14·39
Tues ..	5	14 19·27	0·168	14 19·23
Wed ..	6	14 23·31	0·135	14 23·28
Thurs..	7	14 26·55	0·102	14 26·52
Fri. ..	8	14 29·00	0·069	14 28·98
Sat. ..	9	14 30·66	0·037	14 30·65
Sun. ..	10	14 31·54	0·004	14 31·54
Mon ..	11	14 31·64	0·028	14 31·65
Tues ..	12	14 30·97	0·060	14 30·98
Wed ..	13	14 29·53	0·091	14 29·55
Thurs..	14	14 27·34	0·123	14 27·37
Fri. ..	15	14 24·39	0·154	14 24·42
Sat. ..	16	14 20·70	0·184	14 20·74
Sun. ..	17	14 16·27	0·214	14 16·33
Mon...	18	14 11·14	0·243	14 11·20
Tues ..	19	14 5·30	0·272	14 5·36
Wed ..	20	13 58·78	0·300	13 58·85
Thurs..	21	13 51·59	0·327	13 51·67
Fri. ..	22	13 43·74	0·353	13 43·82
Sat. ..	23	13 35·26	0·379	13 35·35
Sun. ..	24	13 26·17	0·404	13 26·26
Mon ..	25	13 16·48	0·428	13 16·58
Tues ..	26	13 6·22	0 451	13 6·32
Wed ..	27	12 55·41	0·473	12 55·51
Thurs .	28	12 44·07	0·494	12 44·18

TO CORRESPONDENTS, &c.

***All Communications for this Journal should be addressed to the* EDITOR, *at the Office,* 35, Northampton Square,** Clerkenwell.

N.B—All Advertisements to be inserted in the Journal must be forwarded to George E. Mylne, Honorary Secretary, at the Office 35, Northampton Square, E.C. before the 25th of the Month.

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BRITISH HOROLOGICAL INSTITUTE.

THE ANNUAL DINNER.

On Tuesday, February 19th, 1861, the THIRD ANNUAL FESTIVAL was held at the Freemason's Tavern, Great Queen Street. The Chair was filled by VALENTINE KNIGHT, Esq., J. P., the President, who was supported by Messrs. J. F. Cole, C. J. Klaftenberger, and E. D. Johnson, Vice-Presidents, Mr. E. J. Thompson, Trustee, Mr. Churchwarden Webb, Treasurer, Mr. G. E. Mylne, Honorary Secretary, C. V. Walker, Esq., Electrician of the S.E.R. Company, Benet Woodcroft, Esq., of the Great Seal Patent Office, W. S. Wilson, Esq., Barrister-at-Law, Frederick Redman, Esq., Mr. W. Hislop, F. R. A. S., Richard Roberts, Esq., C.E., Mr. James Scovell Adams, Mr. Vestryman Macdonald, Mr. Common-councilman Bennett, Mr. John Forrest Watson, Mr. Franchi, Mr. Gordon, Editor of the Horological Journal, Mr. E. Cox, of the Law Circular, Mr. J. Passmore Edwards and Mr. Read, of the Mechanics' Magazine, Mr. Farmer, of the Clerkenwell News, Mr. Sykes, Mr. Baddeley, Mr De Pecca, and the following Members of the Council: Messrs. W. P. Birchall, W. B. Crisp, T. Gordon, W. Hislop, R. Howard, S. Jackson, V. Kulberg, B. Marriott, H. Richards, J. E. Roberts, R. Schweizer, E. Storer, J. Trewinnard, A. Walsh, R. F. Warman, and a large attendance of the Members and their friends.

The Musical Arrangements were under the direction of Mr. G. A. Cooper, assisted by Mrs. Cooper, Miss Boden, and Mr. Davitt. During the evening several beautiful pieces were executed by Mr. De Pecca, and a pupil of his (Mr. George Talbot.)

The usual loyal and patriotic toasts having been drank, Mr. J. S. Adams, responded to the toast of "The Volunteers."

The CHAIRMAN rose and said, The next toast I shall have the honour of introducing to your notice is one which I am sure you all feel deeply interested in, "The Science of Horology." I have great pleasure in informing you that the gentleman on my left (Mr. Hislop), who has always taken a deep interest in the welfare of the Institute, and I have no doubt will continue to do so as long as he has life and health, will respond to it.

The toast having been drank with all the honours,

Mr. HISLOP said, Mr. Chairman and gentlemen, when our respected friend, Mr. Mylne, called on me this morning, and favoured me with a programme of this evening's proceedings, I found my name coupled with this toast; I then said that I should reserve all I had to say for the present occasion. My own experience tells me that watchmakers are very much determined to have their own way. I also know that the Council of the Horological Institute is by no means an exception to that rule. However, I am not about to inflict upon you a long speech, because I feel that it is very improper to do so after dinner. At the same time I think that we should thoroughly understand what our special duties are. We have met this evening to commemorate the anniversary of an Institution which has for its specific object the promotion of the science of Horolgy. I had the honour to be amongst the few who started the Horological Institute. I was one of its first members: indeed the card I now hold bears the "No. 1." Our simple object was to revive a science which did and does appear to be on the wane, simply from a want of instruction, and because the manufacture is now conducted on the same principles which must govern the production of articles of ironmongery rather than those which should be followed in the making of scientific instruments. Our object, then, is to promote the true science of Horology; to afford facilities for obtaining information with regard to those principles which must govern the construction of the instruments with which we have to do. But we must remember that the only way by which this can be done effectually is for those who have some thoughts about it, joining together heart and hand to promote the object. We must remember that the only way by which we can promote science is by association. You and I may have a certain amount of knowledge upon a subject, but if we wish to apply it to a great and good object we must join together for that purpose. Therefore associations are formed in all branches of science, and there is especial need for one in our own trade; for it requires far more skill to construct a watch or clock properly than to make any known scientific instrument. We know that the astronomer could not get on very well without the watch-makers, and consequently we find that the most eminent astronomers have always been more or less engaged in the construction of watches and clocks. I do not mean that they have dealt with them in the ordinary acceptation of the term, but they have all studied the construction of timekeepers, and have all endeavoured to improve or adapt them to their own purposes. Improvement in the one branch of practical science has always led to discoveries in the other; and hence we find that astronomy and horology have always gone together. In the present day we find horology and electricity united. We find them used for the purpose of conveying time-signals from one part of the country to the other with the greatest ease and certainty, and we find, likewise, our own purpose served in this respect; for, instead of going through the laborious calculations necessary in order to obtain exact time, by the electric current we can get it to within a few tenths of a second. The way in which all this is to be done can only be understood by those who give the matter thought, by those who deem the subject worth while understanding, giving their best consideration to how and when this or that is to be done.

This is especially our work if we would make a right use of that reason with which we are blessed. On the present occasion I shall not go further into this question. I hope we may see all those who love the art joining the Institute; all who wish to learn scientifically the true construction of a watch or a clock; who pursue the art not merely for money, and value money not for mere animal gratification, but who look at horology in an intellectual point of view, because they know that there is in it a great deal to be learned worth learning, and much that is worthy of their attention as reasonable beings. For my own part I love horology not because I get my living by it, but because it is an art worthy of my regard in a scientific point of view. I find as much high scientific knowledge in the construction of a watch or a chronometer as I should discover in the erection of a steam engine, or in the formation of a railway. Looking, therefore, at the article in which we trade—if you please to call it a trade; I prefer to designate it a profession—the horologist stands as high in a scientific point of view as the engineer or the medical man. I must say that I exceedingly rejoice in the existence of the Horological Institute, for I recollect the amount of hard, harassing study I had to pass through when a lad in order to get at anything like knowledge. I found myself encircled and limited by trade secrets. Many days have I spent in reading at the British Museum, and until daybreak at home, in studying some particular point which I felt to be desirable for me to know, so that I might comprehend the various physical laws a knowledge of which is necessary to enable a person scientifically to construct a timekeeper. All this, however, I did cheerfully, simply because I felt the pleasure as well as the necessity of it. This is the grand motive that should guide us all. I know that there is a great deal of jealousy about the Institute, especially amongst the workmen. They imagine that one of its effects will be to bring down wages. In simple truth it does bear upon the rate of their remuneration. If we succeed in raising the status of the workman it can only be by elevating him in knowledge. It is only by that means that we can give him more payment than he has at present. I am not one who considers that excellence consists in cheapness of production, but rather in what the word imports—excellence of production. I conceive that those who do best are always entitled to be paid the highest remuneration. I would, therefore, say to those workmen specially who desire high wages, that the great object they have to accomplish is to qualify themselves to do the best work, and so to command the highest wages, instead of following a rule because their masters or their fathers before them did so. Gentlemen, I shall not detain you longer, because there are many here who have yet to speak. I have very great pleasure in acknowledging the toast, only regretting that a better name than my own was not coupled with it.

The Chairman then rose and said, I am sure after the execution of the artist (Mrs. Cooper) you have just heard sing, you will all be of opinion that a Cooper is not a bad appendage to the Horological Institute. My excellent friend on my left, Mr. Hislop, who has so well defined the science of horology, has said that his name was put down to the toast by the Council, and that he only ascertained the fact this morning. I am sure we shall all be of opinion that in the multitude of councillors there is wisdom; and the wisdom of the Council has also been exhibited by their selection of another representative gentleman, who is a most excellent friend of the Institute, and who I think I may almost describe as its founder, whose warm heart is always prompting him to do everything he can to promote its interests. I am quite sure that the Council have shown their wisdom in appointing Mr. Johnson to return thanks for the toast I am now about to propose—"Success to the British Horological Institute."

The toast was drank with loud applause.

Mr. E. D. Johnson.—Mr. Chairman and gentlemen, it is so usual to import great insincerity into *post prandial* speeches that I feel called upon to ask you to believe me when I say that I am very proud of this compliment—all the more so from the compliment coming from the lips of so good a man and so excellent a chairman as him who occupies the chair this evening. I ask you further to believe me when I assure you that I feel gratified for the honour of being called upon to reply to this particular toast, seeing around me so many gentlemen more able than myself to do justice to the position I now fill. It is true that the opportunity afforded me of founding this Institute was simply default of activity on the part of better men. It is true that I have been enabled to do the state some little service; but when we remember the dictum of a celebrated ethnologist delivered considerably less than half a century ago, and not more than a hundred miles from this room, to the effect that "one watch maker was very much like another watch maker," I do hope that you will believe me when I say that by the manner in which this toast has been received, coupled as it is with my name, I am repaid a thousand-fold. Apart from the dry details of the Institute, which is more properly the business of the Honorary Secretary, I should like—if I have your permission—to say a word or two on the present position and future prospects of this Institute. I think, in the presence of such evidence as the loss of the art by France—I speak now of course of the practical part—and of its wondrous developement in Switzerland, there will scarcely be a man who would object to the form of this Institute; nay, who would not accede to the proposition that it would have been downright dangerous longer to delay its advent; still less do I believe that now the thing is established, and has become a prosperous fact, there will be found any one to say that it ought not to be supported. This Institute, sir, had its rise in a well-grounded conviction, pervading the minds of a few thinking but thoroughly practical men, of its necessity. That conviction having been carried home to their minds by the contemplation of the recurrence of alternating periods of depression and of equally fatal exaltation, periods when merchant, exporter, importer, manufacturer, artisan, through all grades, down to the very lowest and least artistic, were alternately either servile or saucy—periods when one principle, and one principle only, seemed incapable of exception, that principle being the uniform

sacrifice of the art to what was supposed to be personal advantages and to crotchets. We had listened for a great number of years to the spoken opinions upon the division labour, and a great deal has been written upon the same subject. Very few men have been found with sufficient moral courage to set themselves up in opposition to so well-grounded a maxim of political economy, and thus it has occured that all have acquiesced in pushing the principle to an absurdity—of pushing this division of labour, as applied to horology, to the perfecting the machine and to the ruin of the artist. I say the ruin of the artist, I might have said the abolition of the artist, for I am strongly of the opinion, and I know no better words in which that opinion has ever been expressed than those of my respected friend, Mr. Klaftenberger, who emphatically delares that it is impossible, and we must not expect to find a good watch-maker who does not love the art. I subscribe to that opinion, but then I have to ask where, amongst all those who labour in this beautiful art, can you expect to find men thoroughly imbued with a love of the science while they must work on ground reduced by this division of labour to absolute monotony, and in which the necessity for the exercise of the thinking faculty is reduced to a minimum. The removal of this monotony, and the re-arousing of this thinking faculty, are the two main objects of this British Horological Institute. In this country, as in some others, torture is called "the question," and the Council in the exercise of their business are sometimes put to the torture by questions. They are asked by one class, "What is the Institute doing for the benefit of those who subscribe to it?" This seems a very simple question—and so it is. The question possesses within itself no inherent difficulty at all; the difficulty lies in the fact that only those incapable of appreciating the reply would ask the question. To understand this class it is necessary to imagine for yourselves, gentlemen, a number of men—a class of men in fact—compelled to sail a long voyage in a given ship; you will have also to imagine each member of this crew presented with a life-belt, which of course has reference only to accident, or to absolute shipwreck; each man has thankfully received and feels really grateful for the care and forethought of the donor, while they could not understand and could feel no gratitude if the owners were to direct the same amount of care and money to the salvation of the ship with which they must sink or swim. Such is the exact copy of the character of those who ask this question. I do not make this a reply to the question, because we have no list of acts to place before you—on the contrary, I affirm that we have done a great deal, and intend to do a great deal more. Allow me to recapitulate some of our doings. We have erected a home for the art of Horology; you will say, perhaps, that that is doing very little. I assure you I can convince you that that alone has effected a great deal, for have we not thereby redeemed the art from that state of vagabondage implied in the relegation of matters horological to boards of longitude, to meetings of civil engineers, to astronomers, to amateurs? We have a case in point where some £20,000 was expended with very little to show for it but a cracked bell. Have we not established a Horological Journal? Have we not commenced a library, and founded a museum? Have we not engaged the attention of gentlemen who have not only the power but the will also to do good to those whom they find determined to do good to themselves? It is true that at the commencement of such institutions we have to be grateful for comparatively small benefits, but we should in these, as in other instances, be grateful for small mercies. Then, again, be it remembered that we have petitioned the Lords of the Admiralty for a grant of chronometers, with this remarkable effect, that they have given us one, and we have reason to hope that that is but the "thin end of the wedge" into the concession of more extensive grants of the same description. Then, sir, I have great pleasure in announcing to you, and at this meeting, because the credit of the act belongs to the Horological Institute, a fact which no member except myself is cognizant of at this moment, namely, that as representative of the Institute I have this day succeeded in closing a negotiation and completing arrangements which will henceforth place Clerkenwell in permanent electrical communication with the Royal Observatory at Greenwich. (Cheers.) Another question is asked which is felt by all as demanding a reply—a question that every member of the Council feels to be so pertinent, that I cannot do better than give you my view of what the reply to it ought to be. It is asked, How comes it that among the men of mark amongst horologists resident in London, there are men who perhaps have enrolled their names and subscribed, yet abstain from actively endeavouring to promote the interests of this Institute? The answer is, firstly, it is attributable to "that second nature that habit doth beget in a man." Watch makers, chronometer makers, and clock makers have all been so long used to isolation, that they have become slow in appreciating the benefits of co-operation. Then there is a class reason—a class—how shall I designate them? Allow me to put it as I best can. There are certain men in the world, no doubt with very musical souls, but who would not touch an instrument unless they play first fiddle; and as everybody cannot be leader, but some must consent to be second in the band, otherwise there would be no music at all, surely they might be content to follow those who commenced the harmony. So as those gentlemen cannot all be leaders they are content to sit at home and contemplate their own dignity, like a Chinese mandarin or an owl in an ivy bush. Nevertheless I have great hopes of this class, because there are men of very considerable intellect amongst them, and therefore I feel convinced that so soon as they discover what remarkably ridiculous figures they cut, they will see their way to come amongst us. To this anticipation I must, however, append one regret; it is this—it was but the other day that those gentlemen would have conferred immense benefit by their membership and co-operation; their presence would have been considered a great occasion—I was going to say that day has passed. The Institute is an established fact; they will now join and work or stay away as they list; they will be received with open arms; but this fact is certain—the time has arrived, or very nearly so, when office in the

British Horological Institute must be considered a distinctive honour amongst men connected with the art; that it will be strongly contested for, and none can hope to succeed who have not shown a disposition to forward the interests of the Institute itself, by the contribution of time and labour as well as of money; nay, more, I will venture on the present occasion to be prophetical—I do believe the time is not far distant when no solid horological reputation will be to be established without its sanction, I will not say arbitrarily, but when it will be regarded as a man's "guinea stamp" the fact that he belongs to the British Horological Institute.

Mr. E. D. Johnson again rose and said, Gentlemen, when an institution was formed some few years ago bearing the same relation to a particular science as I contend this does to the chronometric art, it was doubted by many whether it would not expire in its infancy for want of funds, arising from the absence of well-known and respected names. I allude to the Institute of Civil Engineers. I do believe in that day that that Institute was saved by one man, Telford; but, at any rate, Telford accepted the invitation of a few young men in the profession to preside over their Institute, and so made the Institute of Civil Engineers, and laid the foundation of the present beautiful superstructure. The Horological Institute was in precisely the same position at its outset. We have received at the hands of a gentlemen present benefits of a kindred description. Doubt will, unquestionably, always pervade the early councils of those who have commenced a new movement; but no man's name comes before us so prominently —perhaps I ought not to say prominently, because it comes up so uniformly—as that of Mr. Valentine Knight. We all felt that in him we had a man of ability and of admirable qualifications for a chairman—from whom envy, hatred, and malice were shut out, in consequence of his separation from the interests of other men connected with the art of horology. That gentleman has not disappointed our expectations; and I therefore call upon you to give expression to our feeling to that effect. He has been our President from the first. I do not know a name that will be more cordially remembered by those who look up to him as having conferred the greatest amount of benefit upon the Institute than that of Mr. Valentine Knight, our present worthy chairman. I trust that as long as he lives, Clerkenwell in particular will take care that no other man occupies his seat. In the first instance I was prepared to oppose him as President, but I did not vote even for my own proposition, upon grounds that have resulted in the conviction that he is the man who carries the largest amount of suffrage; and as long as he condescends to accept the presidential chair, not only will I vote for him—I do not hold with the use of influence at elections—but I do believe that I shall be credited when I say that I shall find a large number of persons to vote for him. It is my pleasurable duty to propose the health of a gentleman so well known—a man who makes himself loved wherever he appears.

The toast was drunk with great enthusiasm.

The Chairman.—Gentlemen, I am sure that I ought to feel, as I do, most deeply grateful for the kind manner in which you have been pleased to receive the toast which has been so elaborately proposed by my excellent friend Mr. Johnson. He has used the word "condescension" in reference to my acceptance of the office of President of the Institute. I shall never deem it condescension on my part to do what I possibly can to promote the interests of any society which tends to the welfare of the parish of Clerkenwell, and more particularly of the watch trade. I can only say, gentlemen, that, having spent many years of my life within that district, and having taken some money out of it, I should be ashamed of myself if I looked back without having a feeling of kindness and good fellowship towards those with whom I was formerly associated; and until the last day of my life I assure you that I shall have very great pleasure in forwarding the interests of all the societies connected with the parish. As long as I am spared, and am enabled to join your efforts, in any shape whatever, either as chairman, steward, or anything else, it will always afford me very great pleasure. The Horological Institute I regard as a society of very great importance. It is a new institution in this country; but I believe there is not a man in the trade who ought to feel satisfied until he has enrolled himself amongst its members. In my opinion, its claims extend even beyond the trade Every wearer of a watch owes much to the profession of horology. There is no man, whatever be his education, who is not indebted to it; no lady, let her engagements be what they may, whether with the dress maker and milliner, or with the young gentleman who is her sweetheart, who is not under obligations to the maker of her watch. We are all dependant upon time—it is the great principle of life. Without a good watch where should we be? I really think that the public at large ought to consider this matter. I should not be ashamed to say to a man I met in the street, "Sir, you ought to put your hand in your pocket and subscribe to the Horological Institute. It is a duty you owe to society and to yourself." I hope that we shall find the Horological Institute supported by every member of the trade, and that every man who has even a common watch will give a donation to it, and that all those who can afford to wear a good one will feel it their duty to become annual subscribers to the British Horological Institute. I thank you, gentlemen, for the compliment which you have paid me, and I assure you that I shall always feel a lively interest in the Institute, and in everything which tends to promote the welfare of the watch manufacture.

The Chairman.—Gentlemen, no well-regulated society can get on without Trustees, and therefore we have appointed some for this Institute. It so happens that I am one of them, although I believe I do not often attend; but we have also a gentleman present who has done good suit and service to it. I believe he is one of the most valuable members you have. I beg to propose the health of the trustees, coupled with the name of Mr. Thompson.

The toast having been drank,

Mr. Thompson, in responding to it, said, Mr. Chairman and gentlemen, my friend, Mr. Hislop, has pleaded as an excuse for not being prepared

properly to address you, that he did not know until this morning that his name would be coupled with the toast. I have still a stronger claim to your indulgence in the fact that I did not know that I should have to address you until I was called upon by the Chairman to speak. I thank you for the honour you have conferred upon me in drinking my health in connection with the rest of the trustees of the Horological Institute. I feel that its success depends not so much upon the trustees as upon the Council, which is the governing body. Your Chairman has told you that he does not often attend the meetings of the trustees. I think that all that we can fairly expect of him is that he will meet us upon these anniversaries, and give us his countenance whenever his presence may be of use to us, and that generous support which we know and feel that his kindly diposition is always inciting him to do. I, however, can plead no such excuse for non-attendance. It is true that through your kindness I have been elected a trustee, and that I am, comparatively, a young man, who has yet to work his way on in life, and you might, therefore, naturally expect from me greater attention to the duties of the office, and that I should be more frequently at the council-board of the Institute, and be intimately connected with its government. All this might have been expected of me in return for the honour you have conferred upon me, and yet I am bound to confess that I do not my duty in these particulars. Not that I shrink from any obligation which may be upon me as trustee. I shall always be prepared to do my duty in that office, which is in fact to give receipts and to take charge of the property of the Institute. When the proper period arrives for valuing the stock you will find that we have done our duty in that respect. Those duties, however, are light, although I should be glad if the Council had more frequent occasion to make use of my very slender ability in that direction. I am, however, obliged to confess that I am so much engaged in other ways that I have very few moments to spare. It would give me great pleasure to attend the meetings of the Council, because I feel that this Institute is formed upon such a basis that its future success is certain. If every member of the Institute would determine to do all that in him lies to further its objects, great results might be expected.

The CHAIRMAN.—Gentlemen, I think that we should be guilty of a dereliction of duty if we omitted to notice one of the most important class of the officers of the Institute, namely the Vice-Presidents. There is an adage that nothing is so easy as to be mistaken. My friend opposite me, Mr. Klaftenberger, has been enjoying himself for the last half-hour with his cigar, and has been laying the flattering unction to his soul that he should not be disturbed. That is not quite so certain, for I have his name down to respond to the next toast, "The health of the Vice-Presidents."

The toast having been drank,

Mr. KLAFTENBERGER said, Mr. President and gentlemen, I rise to return you my sincere thanks for the honour you have done the two other Vice-Presidents and myself. I can only tell you that it always gives me great pleasure to meet the Council, and I am sure that my colleagues in the Vice-Presidency, Mr. Cole and Mr. Johnson, entertain similar feelings. Since this Institute was established a kindred society has been formed at Vienna. I have recently received a letter from that city stating the fact. Several of the best watch-makers in that country have become subscribers to the *Horological Journal*, and have actually learned the English language in order to be enabled to read it. It must give us pleasure to feel that our Institute has obtained such a continental celebrity, and I trust that it will continue to flourish and to do as much good as possible.

Mr. COLE,—Sir, I thank you for the honour of your connecting my name with the Vice-Presidents of the Institute. I feel it to be a high honour to occupy such a position. It will be a great delight to me to see the art of Horology extend to a degree far beyond anything it has yet attained. I hope that by the co-operation of the members of the Institute measures will be adopted for that purpose, and that good will be effected beyond anything at present contemplated. To do this, however, we want the co-operation of all around us. We know that, as regards excellence in the art of horology, England is not surpassed by any country, although I must say that in Paris remarkable beauty has been manifested in particular departments; nothing can be more splendid or admirable than the specimens which have emanated from that city. I particularly notice Monsieur Breguet as foremost amongst the French horologists, and Monsieur Leroi and others of a corresponding stamp. Whilst we recognize this excellence in foreigners, we ought not to forget the admirable results which have been obtained in this country. There are many such instances which might be referred to. We might mention a numerous list of names of English watch makers who have attained eminence in that particular branch of scientific pursuit, but I leave you to recall them to mind; they are sufficient to warrant us in saying that the talent of this country is not for one moment to be forgotten. I have mentioned the great talent manifested by foreign manufacturers, but I hope that it will eventually turn out that by the establishment of this Institute at a period particularly coincident with that of the French Institute, and by the conjoined influence of the two, great results will be attained. I trust that a spirit of friendship will always subsist between them.

The CHAIRMAN.—Gentlemen, there is one other officer whom we are bound to recollect upon such an occasion as this, and that is our friend the Treasurer, who is entitled to our thanks for the exertions he has made, and for the interest he has always taken in the welfare of the Institute. I trust that he has received that support in his department which he is fully entitled to; but if he has not it is not his fault, and it is our duty to help him.

The toast of "The Treasurer and Officers" having been drank with all the honours.

Mr. WEBB rose and said, Mr. Chairman, I have to thank you for the very kind way in which you have brought my name before this meeting; at the same time, I feel some little regret that it has not fallen to other hands than mine to respond to the toast. I thank you kindly, not only for myself, but for the Council, whose names have been joined in the toast. There is no mistake in the fact that

the gentlemen composing that body do work hard, and bring a vast amount of talent to bear in the administration of the affairs of the Institute. Without their assistance we should not have been here to-night, or have had the privilege of calling upon you, sir, to preside over us. Gentlemen, in your kindness you have thought proper to elect me as your Treasurer, and I ask you in return to do me the favour to give me a certain amount of work to do, because I have always been, to use a somewhat vulgar phrase, a working man; and in whatever position you think proper to place me, I simply ask you to give me work to do. It may fairly be said that this Institute has become an established fact. Although I am ready to admit, and I believe you will all agree with me in the remark, that it has now attained such a position that it cannot die, yet if not properly supported it may linger on in a certain stage of existence, which you as its friends would not wish to see it remain in. I am not here to make a speech, because we have plenty of room for that in the Council meetings. Perhaps you will allow me, on this the first opportunity I have had in my position as your treasurer of addressing the members, to call upon those present to support me in it. I have no widows or orphans to plead for, but I have to call upon you to support an Institute upon which the prosperity of your trade materially depends; and the success of which will prevent many widows from suffering, and many workmen from being obliged to seek the aid of charity. I know that the Institute contains the germ of that future prosperity of the watch trade which will prevent the rising generation of operative horologists from having recourse to eleemosynary relief. It has now been placed upon such a basis that, if rightly supported, it will train up young watch-makers upon more scientific principles than hitherto, and enable them to develope their talents far beyond what their predecessors were enabled to do. It will, moreover, train them up to labour not only for their own benefit, but for the welfare of their fellow-men. I believe that all the operations of this Society will work together for good. There are many institutions in this country which have really something objectionable in them, but you will pardon me for saying—it may be a partiality or weakness on my part—that the principles upon which this Institute is founded are really unobjectionable. If proper exertions are made by you, gentlemen, this must be one of the most successful associations in the metropolis. There is an old adage that "God helps those who help themselves," and no sentiment could apply better to our own position as watch-makers. If we only pull together and help one another, I am quite convinced that there are many gentlemen of scientific attainments who will then be ready to come forward and assist us. We have amongst us to-night gentlemen of high scientific reputation who have come from various parts of the country to testify their interest in our welfare. I hope, gentlemen, that you will pardon me in thus travelling somewhat beyond the strict limits of the toast, from which the enthusiasm of the moment has somewhat carried me. I have two pockets, but I assure you that, as Treasurer, they are not too full. I hope tkat before long, in the exchequer of the Institute, the copper will be turned into silver, and the silver into gold, and that you will throw a large amount of work upon your Treasurer, and then those who have joined the Institute late will regret that they did not do so at an earlier period.

The Chairman.—Gentlemen, the next toast I have the honour of proposing is, "The Visitors." All the watchmakers of Clerkenwell may consider themselves a Clerkenwell family; but still we have room for outsiders, and we do not care how many. We have to-day the honour and pleasure of having among our visitors, Mr. C. V. Walker, Mr. Benet Woodcroft, and Mr. Roberts of Manchester, gentlemen whose names are too well known in the scientific world to need any comment from me. My excellent friend on my left, Mr. Hislop, alluded to the connection in the present day between horology and astronomy. I believe that the presence of two of the gentlemen visitors rather tends to prove the truth of that assertion. Long may the arts and sciences go hand in hand. Gentlemen, I beg in your name to thank our friends for their attendance here to-day, and to call upon you to join me in drinking their healths.

The toast having been drunk,

Mr. C. V. Walker rose and said, Mr. Chairman and gentlemen, I assure you that I appreciate most highly the honour you have done me in inviting me to this festive meeting, and also for associating my name with the toast of the Visitors. I am no more than an intruder amongst you (No, no.) I am almost an interloper. (No, no.) I am almost a wolf amongst sheep. (No, no.) I heard of your attempts to call this society into existence at an early day, and I assure you I appreciated your efforts very highly indeed. I considered that while the civil engineering body was very strongly represented in their Institute, that there was a large amount of engineering talent required in the art of horology, and which needed for its encouragement and developement the establishment of such an Institute as this. I feel sure that the science of horology will be advanced by it, and I hope that the day will come when the workmen will feel how essential it is to their interests. I have a model workman in my employ, and he also is an interloper in your business. He has made a clock, and I think that he would not be ashamed to place it by the side of some which your workmen produce. He was originally merely a country gardener. I found him engaged as a check-taker at a railway station. I heard that he was in the habit of spending his evenings in repairing clocks and watches. He has never been in any shop, but he has taught himself by cleaning Dutch clocks and such like instruments. I pressed him into my service in the telegraphic instrument department. At the present moment he is occupied in making clocks and repairing watches. I should only be proud to see all workmen placed in the position of that man, who by his industry and thriftiness has been enabled to purchase for himself a couple of houses since he has been with me. I have been assisting in obtaining a key to the middle passage between the Royal Observatory at Greenwich and this great metropolis. No doubt there are many present who are Fellows of the Astronomical Society, and who have seen in its

published reports of last month, in the notes upon electricity, that they have succeeded in making those keys work, and that the Astronomer Royal will apply them for the purpose of communicating time to other parts of the country. We have taken great pains, not simply in communicating the subject of signals for comparing clocks here with Greenwich time and at Liverpool, but the Astronomical Society have taken steps to have it applied, not as a motive power for clocks, not as a substitute for springs and weights, but for that for which it will be of essential service—the controlling of clocks. Means have now been afforded of showing the time day by day, week by week, and month by month, by the standard clock at the Royal Observatory. There is a large body of eminent men connected with the construction of this ingenious machine. If I could throw out a hint to them I would advise them to bide their time and watch for the construction of some great building where there are some thirty or forty clocks, and take an opportunity to break through the old routine, and not use the common clocks with which we are so familiar, which keep no time at all, but those which will indicate a small fraction of a second. We will now be enabled to come into Clerkenwell with the correct time. Mr. Johnson has told you that he has completed his part of the arrangement to allow the signals of the Royal Observatory to come into Clerkenwell. The part of the arrangement between myself and the Astronomer Royal, the connection between the Observatory and the South Eastern Railway has been completed more than twelve months. We have been receiving your signals at London-bridge twice a-day for many months past. If Mr. Johnson will allow me to take a week or ten day's rest, and will communicate with me on my return, I will assist him in joining up, and no doubt the object so long desired will be accomplished,

Mr. WOODCROFT.—All that I have to say is that I wish very great success to the Horological Institute, and whatever I can do to promote its prosperity I shall be happy to do. I thank you for the honour you have done me in coupling my name with the toast; but all I can say is, with Mr. Walker, that I am an interloper amongst you.

The CHAIRMAN.—We do not understand the term here.

Mr. ROBERTS.—I thank you, gentleman, for the kind way in which you have received my name. I am not connected with horology. I amuse myself a little now and then with clocks. I shall be very happy to do all I can to forward the interests of the Society. I do not know what I can do better than furnish it with a copy of a Table I made on the Expansion of Metals under different Temperatures, and also of Woods, on a much broader scale than is ordinarily used by scientific men. Instead of having pieces of metal 6 or even 1½ inches long to test the expansion, I use them 16 feet long, and the expansion is recorded to the one-hundredth part of an inch in that length. My scale shows very differently to their's, therefore one or the other of them must be wrong. Another thing which I found was this, that there are no two metals which will suit to make a compensation pendulum so well as steel and brass. The reason is, that they have no regular increase in their length with regular increase of temperature. If you raise the temperature to 40 or 50, the piece of metal expands to a certain extent; but the expansion is very different from 50 to 60, and from 60 to 70. Perhaps it would be the contrary; and instead of an enlargement, it would be a decrease. Zinc is a very bad metal for a compensation pendulum. The heat passes down it irregularly. Wood makes a very good pendulum rod, but about once in three times it contracts with an increase of temperature. I do not know the cause for that unless it be the altered state of the atmosphere: There is a column of air upon it, and when it expands it extends the piece of wood laterally, and that will contract it. However that may be, the fact is that about one in three times it contracts with the increase of the temperature. I made a great number of experiments with various kinds of woods, some of which were varnished three or four coats of varnish, and had a strong polish given to them, and so forth; but I found that it made no difference in the woods whether they were varnished or unvarnished; they do exactly the same under the same circumstances. Glass makes by far the best pendulum rod: it gives you a constant increase by increase of temperature. I can furnish you with tables of these expansions if they would be of any service to you. Mr. Walker said something, I think, about time-keepers in connection with Greenwich Observatory. There are two clocks in connection with it which are doing remarkably well indeed. I made a drawing of an electrical clock in a way which I thought would be an improvement over those I had seen before. It can be easily impelled by the pendulum both ways; no pendulum will keep time if it is impelled downwards. It must impel of itself, and have a power to advance outwards.

Mr. MYLNE, the Honorary Secretary, read the following list of subscriptions, which had been received from gentlemen present—

SUBSCRIPTION LIST.

Mr. Val. Knight	£10	10	0
Mr. Jas. F. Cole	7	2	0
Mr. E. D. Johnson	5	5	0
Mr. C. J. Klaftenberger	2	2	0
Mr. E. J. Thompson	2	2	0
Mr. J. C. Webb	2	2	0
Mr. S. Jackson	2	2	0
Mr. James S Adams	1	1	0
Mr. J. E. Roberts, C. E.	1	1	0
Mr. E. Thompson	1	1	0
Mr. John Bennett	1	1	0
Mr. V. Kullberg	1	1	0
Mr. H. Richards	1	1	0
Mr. R. Howard	1	1	0
Mr. W. P. Birchall	1	0	0
Mr. F. R Warman	1	0	0
Mr. E. Storer	0	10	6
Mr. J. C. Collingridge	0	10	6
Mr. B. Stitch	0	10	0
Mr. F. Lecluse	0	10	0
Mr. R. Schweizer	0	10	0

Mr. R. Reineker	0	10	0
Mr. F. S. Wilde	0	10	0
Mr. W. Thoms	0	10	0
Mr. J. Susten	0	10	0
Mr. W. Davis	0	5	0
Mr. W. G. Whiting	0	5	0
Mr. G. Dunkley	0	5	0
Mr. F. Potter	0	5	0
Total	£46	3	0

The Chairman.—After the gratifying information which Mr. Mylne has read to us, I should be ashamed of myself if I missed the present moment in asking you to join me in drinking his health. No Society has a better friend than he is to the Institute. He does not care what amount of trouble he takes in its service to promote its best interests. His services are of a very valuable character. I am very glad to find his name so well responded to, as I expected it would be. Individually I feel deeply indebted to the members of the Society and to Mr. Mylne.

The toast was drank with applause.

Mr. Mylne.—Mr. President, Vice-Presidents, and gentlemen. I was not prepared at the present moment to respond to the toast in any way whatever. I thought, after the excellent speeches we have heard this evening, that I might be excused from saying anything. I can only thank the President for the way in which he has proposed the toast, and you, gentlemen, for the manner in which you have received it. As soon as the Institute was founded I became one of its members, and I have subsequently done my best to forward its interests. Since I have been in office as Honorary Secretary I have done all I could to perform its duties, and when I leave it I shall still take the same interest in the Institute which I have ever done.

The Chairman.—You will not be allowed to leave it.

Mr. Mylne.—You can easily understand the nature of my engagements, and that I cannot devote more than a certain time to an object of this kind. If I give you eighteen months you ought to be perfectly satisfied.

The Chairman.—Not at all.

Mr. Mylne.—I shall be glad to see a gentleman before me take the position. I know that a great deal of the success of an Institute of this kind devolves upon its Honorary Secretary. It is just this—we have thirty-five officers, and what is every-one's business is nobody's business. I shall do all in my power to induce that gentleman to accept the office.

The Chairman.—We have a sister institution in France, and I am quite sure that every member of the British Horological Institute must feel interested in its success. We happen to have a gentleman present who is a member of the French Horological Institute. We shall be very glad to welcome him, and hear from him anything which he pleases to tell us. I will propose to you the name of a gentleman intimately connected with the British Horological Institute, and who is a member of the French Institute also—Mr. Cole, and also the name of Monsieur Lange.

The toast was drank with applause.

Mr. Cole.—Sir, I have had the honour of being a member of the Institute referred to as well as this from their first commencement, along with my friend Mr. Klaftenberger. Since that time to the present, I have watched the proceedings of the French Institute, and I have very great pleasure in expressing myself favourable to all that has emanated from either the one or the other. I should very gladly see them both act in concert. I have no doubt that the correspondence which might take place between them under friendly and amicable circumstances would lead to a knowledge of certain contrivances in regard to science on either side. We have had much information from their journal. We have found them exercising a great amount of inventive genius and talent. I believe that if a proper understanding was established between the two, and a correspondence was kept up between them, it would do much to advance the science of horology, and a step would be gained beyond anything which has hitherto been attained. In connection with every subject there are very great difficulties to be got over, and nobody knows anything about them but practical men, who have gone into the inquiry, and who have laboured to accomplish certain ends, and who know the difficulties and disappointments which arise in connection with these pursuits. All jealousies should be thrown aside if possible, and a perfect union should be established. I do not know by what means it can be done, but if the disposition is manifested the means will soon be devised of bringing it about.

M. Lange.—Mr. Chairman, ladies, and gentlemen, I feel somewhat astonished and flattered at my name being connected with the toast just drank. I am so young, and not being accustomed to speak in public, that really I do not know what to say. Mr. Cole has said so much about the French Institute that I shall add nothing to what he has stated, but simply thank you in my own name, and in that of all the foreign watch makers present. I am sure that I express all their feelings when I say that for the production of a good timekeeper we believe England is superior to all other countries in the world; but you must not forget that we watch makers have two classes of customers, one which wants a real timekeeper, and the other which only wears a watch for show. There must, therefore, be certain manufacturers who will meet the taste of this latter class. We are not here to spoil the watch makers of England. We appreciate your great talent and admire the work you produce, and wish that you may succeed in making all the world believe that a great thick watch is much better than a thin one; but until you have done that you must not think us wrong in supplying the market with those flat watches which are so much desired.

Mr. Roberts again rose, and, as far as we could catch his observations, spoke of some part of the Continent where watch movements were produced at 7½d. each. They were made by machinery. He had seen an astronomical clock which was made to work with such precision that no ordinary clock maker in Paris could approach it. He had machinery which would form the teeth and wheels upon an unerring principle. He had

made a clock of a cathedral, the going motion of which was driven by an eight-ounce weight only.

Mr. John Bennett proposed "The Press," coupled with the names of Mr. Farmer, Editor of the *Clerkenwell News*, and Mr. Passmore Edwards, of the *Mechanics' Magazine*.

Mr. Farmer.—I thank Mr. Bennett for proposing, and you, gentlemen, for responding to the toast of the Press in connection with my name and that of Mr. Passmore Edwards. Whilst sensible of its defects, I am conscious of its merits as an institution; and setting the one off against the other, I believe that there is a sufficiently large balance in its favour to justify a man in feeling proud of his connection with it, in however humble a capacity. I shall not reply to the toast in a national, and much less in an œcumenical, point of view, but merely in its local connection with the Horological Institute. After having for years performed a somewhat itinerant and agitating mission on behalf of free trade, it is gratifying to me to be enabled to settle down in the latter portion of a somewhat long professional life amongst a body of highly skilled and intelligent manufacturers, who represent in a remarkable degree the principles upon which the greatness of this country so materially rests — the harmonious combination of capital and labour. It has been said that an educated people and a free press are the Australia and California of literary men. It is my privilege to labour amongst a people educated upon, to my mind, the best possible system—that of self-reliance, and dependance upon individual exertion for the making and maintenance of their position in the world; a people, of the majority of whose very ar stocracy — its "trap" men, whether two-wheelers or four-wheelers—it may almost be said that they never had a father before them, and the boast of whose independent operatives is almost that they never had a shilling in their lives which they did not honestly earn for themselves. As to the freedom of our local press, why we acknowledge no censorship but that of an enlightened public opinion. Whatever affects the welfare of such a community is deeply interesting to me. I have endeavoured to the utmost of my power to promote its charities; but at the same time I have felt more anxious about the success of that which will render charity to a great extent unnecessary, the prosperity of its manufactures, and I know of no institution which is so adapted to bring about that result as the British Horological Institute. I must, however, confess that I have been disappointed at the amount of support it has received from Clerkenwell specially, and from the metropolis generally. I had hoped that by this time the number of its members would have entitled it to be called a trade institution. Manufacturers are prone to charge upon agriculturists the folly of tenaciously conserving to old habits and obsolete customs. I believe that if we were given to self-examination, we should discover a beam in our own eye which it was necessary to pull out before we could consistently point to that of our neighbour. My experience of life, and my reading of history, convince me that there is no more inflexible law of man's being, whether in his individual or associated capacity, than that if he will not bend his neck to circumstances, Providence will break it for him, and cast him aside as a useless tool for its purposes. There are two great elements of manufacturing prosperity—excellence in art, and production at a cost which will command the world's market. I am far from advocating a Petticoat-lane mode of doing business, but I am convinced that the one element is as essential to success as the other. If a man discovered the great secret of alchemy, but could not produce his gold at a less cost than 100*s*. an ounce, he would have been no benefactor to the world, and have done no good to himself. I have, however, sir, the greatest confidence in a prosperous future for Clerkenwell, derived from its experience in the past. If it could hold its own under such a combination of unfavourable circumstances as that it has had to contend against lately, it is stable enough to meet any future storm. In India, the military mutiny and the subsequent passive rebellion of the civilians have almost annihilated our trade. Our shipments to Australia have been stopped in consequence of its monetary crisis. With America our commerce has for a time been well nigh destroyed by the secession movement. With China we have had an intercourse of bloodshed, instead of an exchange of products. Yet with all these crippled sources of trade Clerkenwell has been enabled to hold its own. May she not then look forward to a period of manufacturing elevation when these temporary causes of depression are removed? If the new Imperial government of India becomes a paternal rule, the unbounded resources of that vast empire will be developed, and we shall there find some of our best customers. Australia will no doubt right herself and become our most flourishing colony; and the mother country at one end of the world and the daughter at the other will be reciprocating benefits. America having sloughed off her diseased members, will become what she has never yet been as a federal republic, a healthy body politic, and our trade with her will be increased and placed upon a better basis. We have, moreover, a right to look for an abundant harvest from the seed which is now being sown in Africa by Dr. Livingstone. If we make a right use of the resources which will be opened up to us, and adapt ourselves to circumstances as they arise, we may postpone the much-talked-of visit of the New Zealander to this country for at least a thousand years; and then, according to the calculation of an eminent theologian, the world will have arrived at a period of its history when it need not care about the sale of manufactures or anything else—the eve of its own dissolution.

Mr. Passmore Edwards at that late hour of the night declined to make a speech. Whatever services the "Mechanics' Magazine" could render to the science of horology would be cheerfully given by its Editor.

The Chairman said that the Press had been proposed; he begged to give the Volunteer Press, and propose the health of his old and esteemed friend, Mr. Gordon, the Editor of the Journal.

Mr. Gordon briefly responded, thanking them for their kind compliment, and said that it would give him great pleasure at all times to do what he could for the Institute.

ELEMENTARY PAPERS

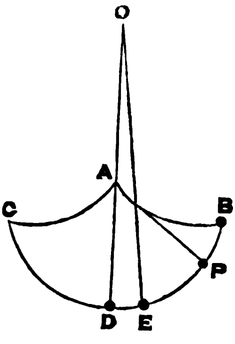
ON MECHANICS AND MATTER IN MOTION.

(*Continued from page* 44.)

On the Pendulum—*continued.*

In all the preceding statements, the effects of friction have been left out of the question; it would, however, greatly influence the result: since in the case of two bodies descending along unequal lengths of the cycloid, the one which traverses the longest space is more retarded by friction than the other. The most effectual way of getting rid of this friction, is to support the body by a string hanging from a fixed point, in the manner of a pendulum. But a body thus supported would obviously vibrate in a portion of a circle; and some peculiar means must be taken to make it vibrate in a cycloid. The very simple means to be adopted depend upon a peculiar property of that curve. If

Fig. 1.



two surfaces be cut out of the form of half cycloids (represented by A B and A C) and they be placed together, so that their extremities join in A, whilst their other ends B and C are in the same horizontal line, a body P suspended from A by a string equal in length to A B or A C, will oscillate from B to C along a curve which is not a circle but a cyloid. From the peculiar nature of this curve it results, that, whether the oscillations be long or short, whether they commence from B, P, or E, they will occupy the same time; since the body will descend along the cycloid in equal times, wherever it commences its descent; and the same law holds good regarding its ascent on the other side. By such a contrivance, then, we might obtain a pendulum which would be perfectly isochronous—that is, which should oscillate in precisely the same time whether its movements be long or short.

But though the plan appears so simple, it cannot be accurately put in practice: for it is impossible to find any material fit to support a pendulum, which would not require some force (however small) to bend it against the two cycloid cheeks, and which would not be in some degree attracted by them when brought into close contact. Hence the operation of such a pendulum would be sufficiently disturbed, for its movements to be less regular than those of a simple pendulum oscillating through small spaces. For if a circle be drawn from the point O, which is at twice the distance of A from D, this circle will so nearly coincide with the cycloid for a short distance on either side of the point D (say to E) that the movement of a pendulum along that portion of the circle will be isochronous, whether they be longer or shorter. If, however, the oscillations be much longer, they will cease to be isochronous: for they will occupy a longer time, in consequence of the greater space to be passed through; since this greater length is not compensated in the circle, as it is in the cycloid, by a proportionably greater inclination. Hence, in the construction of clocks of the best kind, the simple pendulum is employed; and it is connected with the clock-work in such a manner as to oscillate through small spaces, so that its beats always occupy the same time, whether they are a little longer or a little shorter than the average.

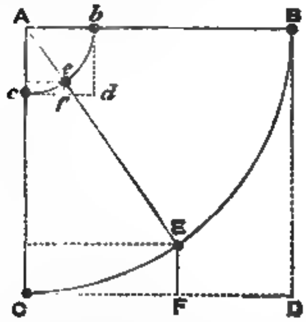
But the slightest variation in the length of the pendulum, that is, the distance of the weight from the point of suspension, influences the time of its oscillation; and this may be readily explained according to the law of the descent of bodies along inclined surfaces, already stated. For it is obvious that, since the ball of a short pendulum has to move down a much steeper curve than the ball of a long one, it must therefore descend much faster; so that a very slight diminution in the length of the pendulum, by increasing the steepness of the curve even in a very trifling degree, will diminish the time of its oscillations, and though this diminution may not be perceptible when two or three, or even twenty or thirty are counted, it becomes very evident when a large number are registered, as they are in a clock.

In regulating a clock, therefore, we shorten the pendulum (by turning a screw at the bottom, which slightly raises the weight) when we desire it to go faster; and lengthen it, by letting down the weight a little, when we desire it to go slower. An alteration of no more than 3-10th of an inch will make a difference of 5 minutes a day in the going of a clock.

The proportion already stated to exist between the lengths of pendulums oscillating in different times—that the length varies as the squares of the times—follows naturally

from the law of the descent of falling bodies—that the heights through which they fall vary as the squares of the times. Thus let

Fig. 2.



A C be a pendulum of any given length, whose point of suspension is A, if the weight be let go from B it will descend through the quarter of the circle whose centre is A, until it reaches its lowest point C, after which it will ascend as high as B on the other side, if permitted to do so. In descending to C it falls through the perpendicular height B D, which is equal to A C, say in two seconds. In one second it will only fall through a quarter of that height; and therefore the length of a pendulum A *c*, adapted to describe the curve *b c* in half the time that is required by A C to traverse B C, must be only one fourth of A C.

The same thing holds good with respect to smaller portions of the circle. The pendulum A C in moving from E to C falls through the same space E F; and the pendulum A *c*, of one fourth the length, in moving from *e* to *c* falls through *e f*, which is equal to one fourth E F, in half the time. In the same manner, a pendulum must be four times the length of A C to occupy twice the time in describing any portion of its curve that is required by A C to describe a corresponding portion of its curve.

(*To be continued.*)

PIERRE JAQUET DROZ was born in 1721, at Chaux de Fonds, and died at Bienne in 1790. Among several remarkable works, Droz constructed a magical and astronomical Clock, which he sold to the king of Spain. Henri Louis Jaquet Droz, his son and pupil, was born at Chaux de Fonds in 1752, and died at Naples in 1791, being 39 years of age. He worked with his father at the three other principal productions which, with the magical clock, made the reputation of these two great artists: namely, "The Writer," "The Drawer," and "The Musician." He stayed some time at London, where he received a very gratifying reception from the king of England. He intended to live in this country, but the climate of Great Britain did not suit him better than that of Chaux de Fonds; he never recovered. Being consumptive, he went to Provence, afterwards to Naples, with the hope of recovering his health, but it was in vain.

METEOROLOGICAL OBSERVATIONS,

Taken at 9 A.M., JANUARY, 1861.

Gray's Inn Road.

REMARKS.

The letters for the weather signify:—b, blue sky; c, detached clouds; f, fog; m, mist or haze; o, overcast or dull; q, squally; r, rain; s, snow; and a letter is repeated to denote much, as rr, much rain; ff, thick fog. Thus on the 11th at 9 a.m. the weather was foggy, but the general state during the day was overcast; the 31st commenced with, at 9 a.m., blue sky and clouds in excess, as the day wore on the clouds dispersed, and left a fine blue sky; hence this day was altogether a very fine one.

With regard to the character of the weather represented by these letters, it would be instructive and enlightening for those who believe in prophetic weather almanacks, to compare their predictions with these, the actual states. It will be seen that such prophets may be occasionally right, but that they are wrong about 25 days out of the month. If matters went the reverse way one might tolerate them, at least as harmless. As it is, they are evidently nothing but

Town and Country.

BRITISH HOROLOGICAL INSTITUTE,

35, Northampton Square, London, E. C.

20th March, 1861.

The great desirability of an uniform system of measurement has long been felt by the manufacturers of chronometers and watches. The decimal division of the English inch has been partially employed in Britain, and the French "line" more generally in France and Switzerland; but in the majority of instances, mere arbitrary numbers referable to no standard whatever have been used, without concert, by each manufacturer of the various parts belonging to the same piece of mechanism.

Not only is this want felt in horology, but also in all the smaller and more exact machinery required in instruments of precision. On a large scale, an attempt has been made somewhat successfully by engineers, to supply the need; and a tolerably uniform system or systems of measurement have been adopted in the higher branches of the engineering profession. A practical instance of the advantages arising from a fixed gauge, is known to every one in the facility with which illumination by gas can now be effected, the various connecting screws being made to the same size and pitch.

The Council of the British Horological Institute have had this matter under their serious consideration, and they have, as an initatory step, appointed a Committee to consider the subject in all its bearings, and to gather information for the use and guidance of those interested in the question, without reference to mere local interests.

The Committee so appointed solicit assistance by correspondence, suggestions, or information, the loan of apparatus, gauges, &c., in order to forward an approximation to so desirable an end as an uniform system of notation and measurement.

It would be premature at the present stage to do more than indicate the course which may probably be taken in this question. When the first report is sufficiently matured for circulation, it will be desirable that corresponding committees should be formed; and should the proposed Exhibition of 1862 be held, it may form a convenient opportunity for personal conference on the subject. Suggestions as to the best method of carrying out the object are also solicited.

By order of the Museum Committee,

W. HISLOP, *Chairman.*
GEORGE E. MYLNE, *Hon. Sec.*

*** Communications to be addressed to the Honorary Secretary, marked "Museum Department."

Society of Arts.—The Thirteenth Annual Exhibition of Inventions, of the Society of Arts, will be opened on the 1st day of April, and will remain open every day until further notice, from 10 a.m. to 4 p.m. Members of the British Horological Institute will be admitted on presenting their cards of membership.

ELEMENTARY PAPERS

ON MECHANICS AND MATTER IN MOTION.

(*Continued from page* 91.)

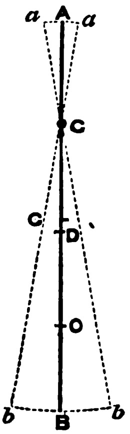
On the Pendulum—*continued.*

The time of oscillation of a pendulum is liable to be affected by changes of temperature; since almost all substances expand by heat and contract by cold; and as already remarked, a very slight alteration is sufficient to produce a decided difference in the going of the clock. In order to prevent this, several ingenious contrivances have been devised, in which the effect of a change of temperature on one part is made to counterbalance itself in another. These are termed compensation pendulums; and those forms in most general use will be described in the treatise on Heat. The simplest is that which is termed the mercurial pendulum; and its construction is very easily understood. Instead of a solid weight, it carries at the bottom a jar containing mercury. The expansion of mercury is much greater, in proportion to the length of the column, than the expansion of the steel or iron rod by which it is suspended; and whilst the latter expands downwards, so as to increase the length of the pendulum, the former expands upwards from the bottom of the jar towards the point of suspension. In consequence of the greater proportionate expansion of the mercury, the rise of the surface of the short column in the jar is enough to compensate for the lowering of the jar by the expansion of the much longer steel rod which carries it; so that the centre of gravity in the jar is always kept at the same point, and the acting length of the pendulum remains the same, therefore, at all temperatures. A piece of dry wood, however, has its length so little affected by heat or cold, that a pendulum whose weight is supported by such a rod, is almost as good as one in which there is a contrivance for compensation; and in many large public clocks this is the plan adopted.

We have hitherto considered the action of the pendulum as if its rod were without weight; and as if the whole weight which it carried were concentrated into one point, the centre of gravity. But this is not actually the case, and the difference comes to be of much importance. For if we consider the whole weight to be made up of a great number of separate particles, and these to be all suspended from the same centre, it is obvious that they will not all oscillate in the same length of time, since some of the particles are much further from the point of suspension than others. Suppose the weight to be a round disc, like that usually employed (which is made thin at its edges, in order to be as little obstructed as possible by the resistance of the air): then, if that weight were cut across into three parts, and these parts were suspended by strings of such a length that they would hang at the same distance from the point of suspension as before,—the middle piece would oscillate about in the same time with the whole weight, whilst the upper piece would oscillate faster and the lower piece slower. Thus we see that the connexion of these parts into one whole, makes the particles near the point of suspension oscillate more slowly than they would otherwise do, or retards them; whilst those more remote are urged forward in their oscillations, by the tendency of the nearer particles to more rapid movement. Or, suppose that a straight rod were suspended at one end, and set to swing like a pendulum; the oscillation of every separate part of that rod would be performed, if suspended by itself, in a different time, depending upon its distance from the centre of suspension; but by their union into one solid mass, those that would oscillate slowly on account of their distance from the centre are hastened, and those that would oscillate more quickly are retarded, by the rest. It is easy to understand, therefore, that the time of movement of the whole rod will be a kind of average of the times in which its several particles would oscillate, if hung separately at their respective distances from the centre of suspension; and that there is some point of its length in which the several effects will be all balanced, all the particles above it having just the same tendency to move faster, as the particles below it have to move more slowly. This point is termed the centre of oscillation; and its distance from the centre of suspension is the virtual or acting length of the pendulum.

The place of this centre of oscillation cannot in general be found except by intricate mathematical calculation, or by very careful experiments. It may be very near the centre of gravity, or it may be at a considerable distance from it,—in fact even far below the extremity of the pendulum. It is very near the centre of gravity when the weight of the pendulum is heavy and the rod light; so that the quicker oscillations of the part of the weight above its centre of gravity are nearly counterbalanced by the slower oscillations of the part below. And if the whole of the weight could be really brought together in the centre of gravity, this would be also the centre of oscillation. But in the case of a uniform straight rod,

whose centre of gravity is in the middle of its length, the centre of oscillation is above this; for if the bar were cut across at this point, and each half were suspended separately at its previous distance from the centre of suspension, the upper half would oscillate considerably faster, whilst the lower half would not oscillate much slower than the entire rod. Hence when the whole rod is united together, the upper parts have a greater tendency to push on the lower than the lower have to drag behind the latter, and the time of oscillation is shorter than it would be if the pendulum had the virtual length of half the rod.



On the other hand, suppose the rod to be prolonged above the centre of suspension, then the centre of gravity is raised, but the centre of oscillation is lowered. For let A B be such a rod, and C its centre of suspension; then the part A C above the centre descends, whilst the part C B below the centre ascends, and therefore exactly counterbalances the tendency of the portion C D (equal to A C) to move with the rest of the rod. This is evident, because if A D were the whole length of a rod, supported upon the centre C, it would have no tendency to move, either in one direction or the other, its two ends being equal. The acting portion of the pendulum is, therefore, the part D B; and the centre of oscillation, O, will be that point in it at which the tendency to quicker movement in the particles in the upper portion, D O, counterbalances the slower movement of those in the lower portion, O B. Hence the centre of oscillation is much below the centre of gravity, G; and if we increase the length A C, of the portion of the rod above the centre of suspension, we shall bring the centre of gravity nearer and nearer to that centre, whilst it throws the centre of oscillation further and further off towards the lower end of the rod.

If instead of a rod, we employ a wire with two weights upon it, the lower one being fixed, and the upper one sliding on the wire, we have a pendulum which within a very small compass, may be made to represent pendulums of many different lengths. For if the upper weight, A, be placed at such a height that the centre of gravity is but little below C, the preponderance of B will be all that there is to put the mass in motion. The case then closely resembles that of Attwood's Machine; since the greater part of B's tendency to descend is expended in causing A to ascend; and the remainder which would oscillate in very short times if left to itself has to move both A and B along with it; so that its rate of motion is diminished just in proportion as their united bulk exceeds their difference. The more nearly the two weights are made to balance each other the less will the difference be, and the slower will be the movement.

Thus, if A and B be each at the distance of $9\frac{3}{4}$ inches, and B exceed A by one-eight of their combined weight, then the tendency of that small quantity to oscillate in half-seconds will have to put in motion eight times its weight, and its rate will be eight times as slow; so that such a pendulum will really be 4 seconds in going through each oscillation, to perform which would require a simple pendulum of $(16 \times 39\frac{1}{7})$ $626\frac{2}{7}$ inches in length. Thus a pendulum not more than a foot from end to end may be made to oscillate in times equal to those of any simple pendulum from a few inches to many feet in length. Such pendulums are for many reasons not so certain in their oscillations as those of the ordinary kind, being more influenced by slight causes, such as a difference in the resistance of the air at different times; and they cannot therefore be very advantageously employed for timepieces. But they are usefully employed in instruments termed "metronomes," which are designed to beat time in the performance of music; and they are extremely convenient for this purpose, since a small case contains the pendulum and the clock work that keeps it in motion; and this pendulum may be readily adjusted, by altering the place of the upper weight, so as to make any number of beats in a minute; and all modern music has the time in which the composer intended that it should be played, marked at its commencement.

From the laws of the action of the pendulum which have now been explained, it is obvious that the material of which the weight is composed, has no other influence on the time of the oscillations, or on the length of time they will continue without

assistance, than that which results from the resistance which each experiences in proportion to its weight. Thus, suppose two balls of the same weight, one of lead and the other of cork, to be suspended by strings of the same length and to be put in vibration, the resistance of the air would be experienced by the cork ball in a much greater degree than by the lead on account of its much greater size; this resistance will slightly diminish the length of each oscillation, and at last it will bring the pendulum to rest. Or, suppose that the two balls are equal in size, so that the resistance of the air is the same; then the cork ball will be retarded most, because the force with which it descends is less, and the resistance bears a larger proportion to it. Suppose the weight to be diminished, whilst the surface remains large: as when a feather is hung by a thread, and made to vibrate; the resistance is then so great, in proportion to the tendency of the feather to descend, as almost to overpower it. Yet, if a feather suspended by a thread were made to vibrate in a space completely exhausted of air, along with a ball of cork and a mass of lead of any weight, suspended by strings of the same length, they would all vibrate in the same times, and would continue their movements for as long a period.

The vibrations of a pendulum may be made to continue for any length of time, by giving it at each oscillation, such a slight additional impulse as may serve to make up for the loss occasioned by friction and the resistance of air. The object of the weight and wheel-work of a clock is to communicate such an impulse, and also register the number of oscillations which the pendulum makes. The pendulum is connected with the wheel-work by a peculiar contrivance termed the escapement; this is so arranged, with reference to the highest wheel, that each oscillation of the pendulum shall allow the wheel to move onward by a space equal to half of one of its teeth; and that the wheel, which is made to turn by the power of the weight communicated to it through other wheels, shall at the same time give a very slight additional impulse to the pendulum. This wheel (termed the scape-wheel) is the one on whose axis the second's hands of the clock is placed, each revolution being accomplished in one minute; it is connected with another wheel, which is made to occupy 60 times as long in revolving, and this carries the minute hand; and this is connected with another wheel, which revolves in twelve times the period, and carries the hour hand. Thus, the scape-wheel registers by the hand which it carries the oscillations of the pendulum up to 60, or one minute; the minute-hand registers the number of revolutions of the second-hand up to 60, or one hour; and the hour-hand registers the number of revolutions of the minute hand up to 12, or in some clocks 24.

In some clocks, there is an additional index of the days; which makes one revolution in a month.

(*To be continued.*)

ON RATING CHRONOMETERS IN DIFFERENT TEMPERATURES.

To the Editor of the Horological Journal.

Sir,—In previous communications I have alluded to the importance of rating chronometers in different temperatures; and I will now endeavour to shew the necessity of performing this operation. If I can awaken attention to this subject, and induce some of those whom it may concern to give it more thought than they have hitherto done, I shall not have spent time and labour in vain, while they may perceive that it is in their power to promulgate truth, advance science, and perfect art, however humbly.

Almost every one knows that the chronometer is preëminently a nautical instrument; and that the mariner relies upon it for a knowledge of his position on the boundless ocean. In order that a voyage may be made with certainty and expedition, it is necessary that the navigator should know his whereabouts on the waters, almost from hour to hour. Science gives him the information, and art furnishes him with the instruments necessary to do this. By the aid of his sextant, and his nautical books, he readily discovers the latitude from an observed altitude of a celestial body, sun, moon, planet, or star, when on the meridian. But the other element of position, longitude, is not so easily ascertained. The problem for finding the longitude consists in determining the true mean time at the place, and the true mean time at Greenwich, at the same instant. The accuracy of the longitude depends upon the correctness of these respective times, since their difference gives the longitude. The mean time at place is found by an easy calculation based upon an observed altitude of the sun, star or planet,—not on the meridian, but when about at least two hours from the meridian,—and the latitude of the place. When the altitude and latitude are correctly known, the time deduced will be accurate to

a second; but even a small error in either or both, will not affect the result sensibly. There is therefore little difficulty in ascertaining the time at the ship. The Greenwich time is obtained from the chronometer, and the majority of navigators cannot find it by any other means. Nautical astronomy teaches a method of finding the Greenwich time by what is called the Lunar Problem; but very few navigators study, much less practise it. Indeed it is not required by the government examiners as part of the professional attainments of the commanders of our finest merchant ships. It is therefore not surprising that it is very little understood and scarcely ever practised. Mariners are then, generally speaking, dependent upon the chronometer for the longitude. Should that fail they would be reduced to rely on the results of the "dead reckoning" for their position on the ocean, and such reliance, from the unavoidable errors attending navigation by log-line and compass, would render ocean navigation very insecure and increase the duration of voyages.

Lunar observations are difficult to take, and the calculation of the Greenwich time is tedious, long, and laborious. Only skilful observers, who have good sextants, can take good lunars. Only good computers can rely upon their calculations. Much practice, both in observing and in computing, and also in using astronomical tables, is necessary to make a good "lunarian," and tact and patient skill are equally necessary qualifications. Yet it should not be forgotten by teachers of navigation (who appear to overlook the problem), as well as by navigators, that lunars afford an excellent check on the rate of a chronometer while at sea.

Captain Toynbee, F.R.A.S., has published a pamphlet on "Lunar Rating," which deserves careful study from all persons concerned in nagivation. By his lunar observations in a passage from Calcutta to the Cape in 1854, he found that, had he depended on the rate given at Calcutta for one of his chronometers, he would have been in error 110 miles in longitude, and had a daily rate of 7·7 seconds more than the truth.

The chronometer is intended to show mean solar time. Could it be made to do so accurately, the great problem of determining the longitude at sea would be settled for ever. However, like all the works of man, it is subject to error, and is not perfect. Perhaps it never can be made perfect. Nevertheless it does not become us to console ourselves with that thought, and say, "let well alone." With the chronometer, as with all things, let our motto be, "from good to better, thence to best." Faults and imperfections are susceptible of amendment and improvement; and above all things they should not be disguised or denied. Many chronometers are faulty in workmanship; no chronometer is perfect, however good the workmanship. Then from accident or constant use, they are all liable to derangement. From these considerations, therefore, chronometers require the greatest attention from those who use them, or they may prove deceiving guides. Chronometers are extensively employed in navigation, no commander of a ship proceeds to sea now without at least one, while their employment by other persons is very limited. The navigator readily discovers that his chronometer is by no means an unerring guide. He finds it to be imperfect, yet he knows, generally, nothing of the nature or cause of its imperfection. He buys his instrument on the faith of the maker, or rather the reputation of the seller, and it is his constant practice to entrust it to a person, calling himself a "rater," to have its error determined, and to take charge of it while he is in port. Considering that the chronometer is an invaluable, almost an indispensable instrument to mariners, in this age of clipper ships and steam vessels, making long and rapid voyages, and that few commanders of merchant ships could find the longitude without it, they ought to take the greatest possible precaution to assure themselves of the degree of dependence which may be placed upon it, and to guard against its causes of error.

In order that the mariner may be able to find the Greenwich time from his chronometer, he is furnished, by the "rater," with its daily gain or loss, which is called its *rate*, and is informed how much it was fast or slow of Greenwich time on a given day, which is its *error*. The mariner very seldom takes the trouble to ascertain the error and rate himself; in busy ports he has not the leisure if he had the inclination. As is the universal practice, he supposes this rate will be uniform during the whole of the voyage; he is not led by the rater to suppose otherwise, and he has never received, from any of his instructors, a knowledge of the scientific principles of the construction of the chronometer, or of the laws governing its performance. It is high time such instruction were diffused among sea-faring people; they have been kept too long unacquainted with the inperfections of their instruments of navigation. Makers and sellers of these instruments must look to it, for mariners are begining to require that the defects of their instruments should not be disguised;

and those who act the most straight-forwardly will be the most patronized. Lately a ship-owner brought an action against a chronometer maker for selling him a defective instrument. It was bought second-hand, but warranted. "When about 60 days out the captain fell in with a brig, and on comparing notes with his brother captain, found himself more than 40 miles out of his reckoning on account of the inaccuracy of his chronometer. He subsequently took several lunars and by their result he was confirmed in his opinion that the chronometer was not to be depended on. Eventually, when some days later than he had calculated on, he arrived at the Cape, he ascertained that he was almost two degrees out of his reckoning." It was alleged that the chronometer had not been regulated with sufficient care, and it was stated that the action was brought from no pecuniary motive, but because "shipowners were dependent for the correctness of their instruments upon the vendors of such instruments, and on account of the risk to life and property which might arise from carelessness on their part." Although the verdict was for the defendant, the case is worthy of notice, because it shews the increase of attention paid to the correctness of nautical instruments by both shipowners and mariners.*

It is well known to chronometer makers and raters, that chronometers, especially such as are used in the merchant navy, cannot be expected to keep the same rate during a whole voyage, in which a ship may pass through nearly all changes of climate, because the rate alters more or less, according to the goodness of the instrument, with change of temperature. Mariners should therefore be furnished with rates found in different temperatures, which can only be done by trial by timeing the chronometer in artificial, as well as in existing temperature. Without such trial, or test, no idea can be formed of the variation of rate due to alteration of temperature, as it differs much in different time-keepers. Such a test, from the first invention of chronometers, has been applied, at the Royal Observatory, to those purchased for the Royal Navy. For some years past the Liverpool Observatory has performed a similar service (but one advisedly not so severe) for the merchant navy. "The advantage of such means of proof, are now also avaliable at Glasgow, New York, Singapore, and other places.† It is not limited to the captains, and those who depend on the management, but it extends to the makers of the instruments, who may by fair trial establish such a reputation as will tend greatly to their advantage."

There is now no doubt that it is a process which should not be neglected, and will, consequently, be more attended to. The chronometer makers of London, now having their Horological Institute, might surely make some trade arrangement for having an uniform test applied to their productions, similar to that afforded to the Liverpool makers by the Observatory, of the benefit of which they readily avail themselves, having found that they cannot perform the test so effectually themselves, and that, if they could, they could not afford to devote sufficient time to it. For the purpose, properly constructed heating and cooling apparatus must be provided, and the means of obtaining true Greenwich mean time, established, which might be by telegraphic communication with Greenwich. All this is no doubt expensive, but union is strength, and a wealthy body like the Horologists of London, could have no difficulty on this score. It would certainly be beneficial to makers, if not to sellers, and be the means of stimulating improvements.

The statistics of the chronometers rated at the Liverpool Observatory are certainly instructive. Chronometers generally lose on their rates in high and low temperatures; and Mr. Hartnup's Tables shew that out of 100 instruments, only 14 gained on their rates by changing the temperature from 60 to 40 degrees, and only 20 gained on their rates when the temperature was raised from 60 to 80 degrees, the others all lost time in 40 and 80. The range of temperature for testing purposes need not be lower than 40 nor higher than 90 degrees, unless for special reasons; indeed very few chronometers can stand greater extremes, for it would seem that the oil in the works becomes thickened, glutinized, deteriorated, or driven off, and the performance is deranged from this cause, if not from others. I am persuaded that it is objectionable to submit a chronometer to a great and sudden change of temperature; its rate would be different very probably, when returned to a given temperature.

The following Table will illustrate the results obtainable by rating in various temperatures.

* Vide "Shipping and Mercantile Gazette," of 17th December, 1860.

† "Passage Table, and General Sailing Directions," by Admiral Fitzroy, F.R.S.

A		B		C		D		E and F		G	
Daily Gain.	Mean Temp.	Daily Loss.	Mean Temp.	Daily Loss.	Mean Temp.	Daily Gain.	Mean Temp.	Daily Gain.	Mean Temp.	Daily Gain.	Mean Temp.
s.	°	s.	°	s.	°	s.	°	s.	°	s.	°
0·4	63	12·2	49	3·0	62	0·9	62	16·0	52	1·2	45
0·5	61	9·7	51	2·9	63	1·0	63	15·8	53	1·8	75
0·6	60	10·2	51	2·8	64	1·2	63	*—1·5	80	1·5	80
0·9	60	11·2	51	2·7	62	1·2	64	—1·8	85	1·2	54
1·1	61	9·5	51	2·7	67	1·0	62	13·1	65	0·8	53
1·5	58	7·0	53	3·7	80	1·3	67	13·9	60	1·3	51
1·4	56	7·3	52	3·7	85	1·3	67	15·7	56	1·4	51
1·4	55	11·7	53	3·7	85	0·8	67	15·0	57	1·3	52
1·5	54	14·6	52	2·6	70	1·2	67	16·9	55	1·6	51
1·6	55	18·4	55	2·4	68	1·1	68	— 1·5	53	1·3	50
1·7	53	9·1	55	2·3	67	1·2	66	— 1·8	55	1·4	52
2·0	54	10·6	52	2·2	67	1·2	68	— 8·9	78	1·4	45
2·0	52	9·2	50	2·2	68	1·3	67	—11·5	83	1·0	40
1·9	53	8·3	48	2·3	67	1·3	67	—12·0	84	1·3	50
2·0	53	11·5	47	2·4	66	1·2	67	— 2·0	55	1·6	51
2·1	54	17·6	47	2·2	63	1·5	68	— 2·4	55	1·5	51

* The Minus sign indicates a losing rate.

A, was new and gained upon its rate as new chronometers are always found to do for from two to eight months. Mr. Hartnup writes, "this tendency to gain appears to be caused by a change which gradually takes place in a new balance spring; the spring must be made hard to insure good performance and the harder the spring the longer the chronometer appears to gain. Old chronometers with new balance springs, gain as much as new chronometers."

B, had a very irregular rate in the same temperature, and was quite unfit for use at sea.

Among the causes of such irregularity, that of the chronometer being badly balanced or fitted in its gimbals is one. Should the box be too small, or friction too great to allow the instrument to swing freely and easily, or should it not be nicely balanced, the performance will be affected, for it is adjusted to the horizontal position, and the object of the gimbals is to permit it to keep this position during every movement of the ship.

C, had been compensated very fairly, but its rate in low temperature was not ascertained.

D, had a steady rate in temperatures between 60° and 70° but was not tried in others.

E and F, are examples of the performance of chronometers which have not been properly compensated.

Such chronometers as these have led mariners to believe that their time-keepers have a "sea rate" different from the "shore rate;" because the average rates which they have been found to keep at sea have differed from the average rates obtained in a steady temparature on shore. They attribute the alteration to the change of position, the motion of the ship, or the magnetism of the ship, while the true cause is more likely change of temperature. It has been found that this discord is not apparent when the rate corresponding to the mean daily temperature is used,—not however with such instruments as E and F, or A or B, these in their present state being unfit for sea use. Mr. Hartnup observes, "about five per cent of the chronometers which have passed through the Observatory are altogether unfit for nautical purposes. With regard to the remaining ninety-five per cent, it appears that very great dependence may be placed in them if we take into consideration the change of rate due to change of temperature."

G, had a steady rate, and perhaps its compensation could not have been made more perfect.

This method of rating chronometers in different temperatures has demonstrated that a variation of a few tenths of a second, or even a second or two, will take place in the best compensated time-keepers, absolute perfection as to compensation, being, it would seem, impossible. "Chronometers," says Mr. Hartnup, "which will bear a change of temperature of 20 or 30 degrees, and in which the extreme difference between any two days for thirty or forty days in succession does not amount to more than one second or one second and a half, may safely be taken as first-rate marine time-keepers." It is therefore very important to know how a chronometer has been found to perform, under those ordinary thermal conditions to which it may be subjected, as this information exhibits the character of the instrument, and shews how far it may be relied upon at sea. No one can deny that the chronometer is a necessary instrument to the mariner, and it must also be acknowledged that to test its accuracy of performance, and to give its true error and daily deviation from mean time are important, if not necessary, to the certainty of navigation. There can be no justification for keeping the navigator in ignorance of the imperfections of his instruments, of whatever kind. The compass, chronometer, sextant, barometer, aneroid, thermometer, the most useful of nautical instruments, are all susceptible of error, arising from original defects in the manufacture, or from accidental derangement; and from their importance to modern navigation, it is essential that the navigator should be acquainted with the scientific principles upon which their construction and use depend, as well as aware of the nature of the errors to which they are liable, and know how to determine and correct for them. This knowledge, which is not at present required by the government examiners of officers for the merchant navy, is little attended to by the majority of persons concerned in the scientific part of the navigation of a ship; but the necessity for it is becoming more and more apparent, and eventually it must form part of the system of examinations, if those examinations are to be worth anything at all as criterions of the competency of persons to take charge of the clipper ships and steam vessels of the day. Makers and sellers of nautical instruments must accommodate themselves to the requirements of the art of navigation, and in this age of long and expeditious voyages, too much precaution cannot possibly be evinced, nor too much nicety displayed, in making and perfecting, as well as in using, those instruments which art, working upon science, has created for the purpose of guiding the mariner, with certainty and dispatch, over the expanse of ocean to his far unseen port.

Columbus had not an azimuth compass, nor a sextant, nor a chronometer, nor a patent log, and he, and his immediate successors, were months making the voyage across the Atlantic, which is now performed in less than a month by sailing vessels, while steamers do it in ten days. The early voyagers took about three years to circumnavigate the globe; it is now done in eight months. It is surely not too much to say, that the chronometer and sextant have been as instrumental (especially the former) in bringing about this result as the modern improvements in naval architecture, or discoveries in geographical, hydrographical, or meteorological science. The hardy but ignorant navigator will perhaps boast that he could sail the seas without these modern nautical instruments. He could do so, only with much less certainty, expedition, security, comfort, and profit.

Speaking of the chronometer, it is not too much to say, that ships whether propelled by wind or steam, could not make the surprisingly quick passages that they now do, nor be navigated with so much security, without its aid. For our knowledge of the wondrous world which we inhabit, we are greatly indebted to it. It has enabled navigators, surveyors, and travellers to fix with certainty geographical positions, and define the extent of land and water; and has certainly been the means by which we have arrived at our present knowledge of the currents of the oceans, which is of much importance to navigators.

The more perfect we can make nautical instruments, and the more largely we can extend our knowledge of natural phenomena on the seas, by so much the more shall we improve our means of communication and transfer between distant parts of the world.

A grand achievement indeed is the chronometer in its present state; and a highly useful invention has it proved to mankind. Much genius, talent and skill, and great and untiring industry, study, and patience have been the means of devising and so far perfecting it. The lives of great men have been devoted to it. They have earned fame, if not in all cases fortune also, by their successes; and let not those who follow in their steps imagine, although the harvest is reaped, that the fields are not worth gleaning. I am, Sir, your's respectfully,

R. Strachan.

4th January, 1861.

REPEATING WATCH, BY ARNOLD.

Mr. Arnold, of Devereux Court in the Strand, watchmaker, in the year 1764 had the honour to present his majesty with a most curious Repeating Watch, of his own constructing, set in a ring, of which the following are the particulars:

The Movement, complete, is 2 dwts. 2⅛ grains.
Great Wheel and Fuzee, 2¾ grains.
Second Wheel and Pinion, ¾ grain.
Barrel and Main-spring, 3½ grains.
Third Wheel and Pinion, 1-9th of a grain.
Fourth Wheel and Pinion, 1-10th of a grain.
Cylinder, Wheel, and Pinion, 1-16th of a grain.
Balance, Pendulum, Cylinder, Spring, and Collet, two-thirds of a grain.
The Pendulum Spring, 1-300th of a grain.
The Chain, ½ grain.
Barrel and Main-spring, 1¾ grains.
Great Wheel and Ratchet, 1 grain.
Second Wheel and Pinion, 1-7th of a grain.
Third Wheel and Pinion, 1-8th of a grain.
Fourth Wheel and Pinion, 1-9th of a grain.
Fly Wheel and Pinion, 1-17th of a grain.
Fly Pinion, 1-20th of a grain.
Hour Hammer, ½ grain.
Quartèr Hammer, ½ grain.
Rack, Chain, and Pulley, 1½ of a grain.
Quarter and Half-Quarter Rack, ¾ grain.
The Quarter and Half-Quarter Snail, and Cannon Pinion, ¾ grain.
The All-or-Nothing Piece, ½ grain.
Two Motion Wheels, 1 grain.
Steel Dial Plate with gold figures, 3½ grains.
The Hour Snail and Star, ½ grain, and 1-16th of gr.

The size of the watch is something less than a silver twopence, it contains one hundred and twenty different parts, and altogether weighs no more than 5 dwts. 7¾ grains.—*Annual Register for* 1764, p. 78.

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

(Continued from page 69.)

1843, October 21.—No. 9915.

MYLNE, George Edward.—Watches made with sinks in the pillar plates for the barrel, third and fourth wheels and fuzee; whereby full framed watches may be made flatter than heretofore. The fuzee is similar to the plain or common fuzee, but it has a thin circular steel cap, and is inverted, and is cut the reverse way.

[Printed, 8*d.* See Repertory of Arts, vol. 4 (*enlarged series*), p. 91; Mechanic's Magazine, vol. 40, p. 318; and Engineer's and Architect's Journal, vol. 7, p. 155.]

1843, November 25.—No. 9969.

LUND, John Richard.—Constructing compensation weights with laminæ of brass or steel round them, by the expansion and contraction of which, parts of the compensation weights, which the patentee calls the "correcting weights," will be acted on. One end of the correcting weight is made of gold, and as the temperature approaches 30° or 80° Fahrenheit is carried nearer to the centre of the balance, thereby varying the effect of the weight on the balance The correcting weight must be adjusted in a particular way for mean temperatures, and its effectiveness very much depends on the distance between the said end made of gold, and the pivot on which the weight turns. The patentee describes two forms of correcting weights.

[Printed, 1*s.* 3*d.* See Repertory of Arts, vol. 4, (*enlarged series*), p. 1.]

1843, December 21.—No. 9993.

INGOLD, Pierre Frederick.—Relates to machinery for making parts of watches and other timekeepers. On the frame of the machine is clamped the mandril which is hollow; a table is also clamped to the frame, on which table are fixed on hinged joints the slide rest, the drilling frame, and the countersinking rest; these joints are to allow these "tool rests" to be readily thrown in and out of action. The mandril is bored throughout, and into it are fitted at each end brass bushes, sliding in which is a cylinder, which has screwed in it, by a left-handed screw, the cutter head which holds the facing cutter; this cutter, has screwed into it another cutter; the large cutter faces the back of the watch plate, and the small cutter cuts it partially out of the blank or rough metal. A lever, working on a joint bolted through the back of the mandril head-stock, is used to bring the tool up to its work; the depth of the cut is regulated by an adjusting screw. There is a stop to keep the facing cutter out of action. The cylinder is also truly bored with the axis of the mandril, and in it slides a cutter holder, which carries the cutter which cuts the motion wheel, countersinks the adjusting screw, and regulates the depth of the cut. There is also another tool and cutter, similarly fitted, that slides in the cylinder, and is used to made the countersinks of jewelled holes. The eccentric slide works between bevilled guides. The chucking plate is divided on its face, and to suit the number and position of the wheel, countersinks pivot holes, upper plate and cock, screw and steady pin holes to be made in the watch plate. In the slide rest are used tools for facing; for facing the edge of the upper plate; for chamfering the edge of the upper plate; for cleaning up the pivot holes; and tools for the countersink pivot holes. The drilling frame is fixed to the main plate by a double joint, so that it may be used for other purposes also. In the countersinking rest are used the countersinking tools. When in use, their cutting edges like those of the tools used in the slide rest, are

true with the axis of the mandril, as is also the axis of the drilling spindle. The invention also relates to a machine for stamping wheels, and also polishing the inner edge of the rim and the inner edges of the arms of the wheels at the same time. The principle on which this machine acts is not to punch the wheel out of the metal blank, but to punch the metal blank away from the wheel, leaving the wheel in the same position as when first put into the machine. The inner edges of the rim, and the edges of the arms are polished at the time the metal is punched away from the wheel, by means of an enlarged and highly polished part of the punch " taking off a very thin sliver of the metal, thus removing " the bur of the punch," while the highly polished surface of the enlarged part burnishes up the surface from which the sliver has been cut.

[Printed, 3*s.* 3*d.*]

1844, October 14.—No. 10,348.

NICOLE, ADOLPHE.—The patentee claims,—

1. Winding up watches by means of a rod running through the handle with a nob at one end, and a bevilled pinion at the other, which takes into a wheel, which wheel takes into another fixed on a plate, fixed by screws but capable of being moved on its axis in such a way that, if the rod be pressed in, it gears with and moves the wheel fixed on the fusee, and if the end be pulled out the wheels which communicate motion to the hands.

2. An additional second hand capable of being stopped and moved on as required, and made to arrive and start from a given point instantaneously. The additional wheel is carried by a cam wheel which moves freely on the axis, and this is pressed by means of a spring against a small steel wheel fixed upon the axis, by which the cam and small wheel travel round together. The cam wheel can be stopped by means of a lever moved from the outside of the watch, which lever coming under the said spring lifts it. The cam wheel is heart shaped, and a lever moving on its axis acts on it and brings it back to its starting place; this lever can be moved from the exterior of the case.

3. An escapement very similar to the ordinary lever escapement. The pallet which receives the impulse from the upper escape wheel, is similar to those used in the duplex escapement, but turns the contrary way. This pallet fixed on the axis of the balance, receives the impulsion of a spring, which spring stops against a screw (placed in front of the arm of the escape wheel) ready to be brought back to its old position by the next escape wheel tooth on the return of the balance. Another escapement is similar to the above with regard to the spring and the mode of giving impulse to the pallet, but varies in the mode of stopping the wheel, being similar to the duplex escapement as regards the wheel and roller.

4. Relates to the arrangement of banking pins on the arms of the balance.

[Printed, 7*d.* See Repertory of Arts, vol. 7, (*enlarged series*), p. 151.]

(*To be continued.*)

METEOROLOGICAL OBSERVATIONS,
Taken at 9 A.M., FEBRUARY, 1861.

Gray's Inn Road.

REMARKS.

The letters for the weather signify:—b, blue sky; c, detached clouds; f, fog; m, mist; o, overcast; q, squally; r, rain; s, snow; and a letter is repeated to denote much. Thus the weather of the 5th was overcast and very squally; on the 20th at 9 a.m, it was overcast; and throughout the day there was much rain accompanied with heavy squalls.

The barometer which had been very steady at about 30·25 from the 26th January to 1st February, rose rapidly on the 1st, and reached 30·715 at 3 p.m. on the 2nd. With the steady barometer the wind remained between SW and W, and the weather was mild and generally fine. The 2nd was a very fine day though a little colder, with a NNW wind, but this weather was of short duration. The rise in the barometer was indicative that the wind would veer to the northward, that the temperature would fall, and the rapidity of the rise that the coming changes would be brief. Accordingly from mid-day of the 2nd the barometer column began to fall, and continued falling till 5 p.m.

BRITISH HOROLOGICAL INSTITUTE.

BOTANY, AS APPLIED TO ORNAMENTATION.

By Dr. C. Dresser, F.L.S., F.E.B.S.

The First of Three Lectures, *delivered to the Members of the* British Horological Institute, *on the Evening of the 7th February,* 1861.

Mr. J. F. Cole, V. P., in the Chair.

The Council of the British Horological Institute has done me the honour of requesting me to lecture to you this evening. It has been suggested, that it would be desirable as far as possible to make these lectures useful and instructive; I am therefore not about to attempt to give what is called a "popular lecture," merely to give amusement, because that can be got much better elsewhere. The special object I have in view is to impart to you, as far as I am able in the time allowed me, some of those laws which govern the development of the vegetable structures, looking at them in an ornamental or æsthetic light more particularly. I shall submit to you, as far as possible, the laws which govern plants in their growth, which are the very laws which govern the production of ornamental composition.

In the first place, I must say a few words on the nature and province of ornamentation. We speak very generally about becoming ornamentalists; but we should first ask ourselves the question, What it is to ornament? It is to make beautiful, to render objects pleasing. It is not merely to dab on faces and colours; simply to scratch the surface all over with the point of a graver; but to render the article absolutely beautiful, so that the beholder may feel a thrill of delight in his heart, as he looks at it. Beauty arises from the absence of any want. Although I shall have to bring before you natural objects as the best specimens of ornamentation and beauty, yet it does not necessarily follow that every thing is beautiful because it is natural. Even amongst plants, it is a question whether we have not some which are really ugly. I remember when conversing with my friend Dr. Tindal, he remarked, "Certainly all things in nature are not very beautiful. The braying of an ass is certainly very natural; but it is anything but melodious." It is obvious, that in order to be able to beautify, much knowledge must be possessed by the artist. A knowledge of principles is to a great extent, the source of ornamentation. Judgment is indeed necessary, but great knowledge is also absolutely essential, if you are to become great decorators. I do not think that this is sufficiently understood or felt by persons engaged in such pursuits. The first requisite for a great ornamentalist is to have his mind refined. Our success must depend very largely upon the refinement of our tastes. At first we like certain things, which, when our tastes become more refined, we learn to dislike; and, on the other hand, we learn to like certain things which we at first could not appreciate. It is the office of the beautiful to give pleasure, not only to the uneducated, but also to the most refined of tastes; to those whose senses have long been most laboriously cultivated, whose possession of wealth has, in many instances, given them opportunities of refining their minds by beautiful works of art in all the kingdoms of nature. Still, it is our prerogative to administer delight even to these.

These remarks are especially applicable in your own case, for you are celebrated for producing beautiful watches; not those of a low standard of merit, but those of the refined description. Persons wanting first-class watches are generally those who can afford a first-class education, and whom, therefore, it is most difficult to please. The longer we look at a neat specimen of ornament, the more beautiful it will become in our eyes. We may be pleased at first with a thing which is not really good, but we grow tired of it; but if it is truly fine, we see increased beauty in it every time we look at it. I remember a friend of mine illustrating the same truth by a reference to the works of Milton. He said, that if we read Paradise Lost once, we were pleased with it; twice, a great deal more so; and the third time, we perceived more beauty still in it; that every time, even, you read the book, you discovered new beauties in it. Although I am scarcely prepared to go to that extent, still I must admit that, if an ornament is really beautiful, the longer we look at it, the more satisfied we become with it. How many objects accomplish this? Most of our old cathedrals awe us by their solemn grandeur. In the Crystal Palace, the Alhambra Court overwhelms us by its lavish richness and its almost superfluous glory, and the Greek Court hushes us to silence by its sweet and

exalted refinement. St. James's Hall, again, transports our spirits to a purer world than this. Its beauty is excessive, thereby proving that our reason is exalted, and our judgments are entranced by it. The proportion of the parts is just; the enrichment is glorious; the colours are harmonious; and the nation which is enriched by such results of glory should do honour to the man (Mr. Owen Jones) who has created them. Would that the nation should use such men more while they have got them; for I am strongly persuaded that when it is too late, we shall extremely regret that we have not employed his powers in our behalf much more than we have done.

Music and decoration are sister arts. Does not music affect and delight us? So should art. The papers upon our walls usually do not accomplish this end, and this is one very strong proof of their want of beauty, or in a vast number of cases of their ugliness. I think that, as a general principle, we may state that beauty could be manifest in our productions in proportion to the revelation of the mind in the ornamentation. The less manifestation there is of mechanical agency, the better the thing is. The more the mind is developed, the more beautiful will the object become. Because man is superior to all other beings, he is endowed with mind, and therefore receives an enormous amount of delight from any manifestation of mind. Let us illustrate this fact by a picture. We are familiar with the productions of the celebrated artist Martin. They are very commonly out of drawing, and are in this respect bad, but who does not receive delight from beholding them? Look at his pandemonium, or one of those pictures where the buildings are diminished and diminished, till they are lost in the far off distance. Tiers of palaces are piled one on another, and there is such a manifestation of mind in the picture, that we are delighted with what we see, although we know that there are certain defects in their mechanical production. Architecture and ornamentation are both subject to rule or law, which have to be learned by hard study. It is not merely drawing, but intelligent drawing. The ear can be refined and cultivated, so that we are enabled to detect and appreciate delicacies in harmonies which were at first undiscoverable. In like manner the taste of the ornamentalist has to be cultivated and refined. This is a point which ought to be impressed upon your minds very strongly, that however deficient our tastes may be it is possible to refine them. Any student of music can remember the time when he could not find that delight in harmonies, which his matured judgment and refined ear subsequently enabled him to perceive the beauty of; and on the other hand, whereas he was pleased with jarring sounds, his ear has learned to dislike them. In like manner, ornamental taste can be refined, till at last the student begins to appreciate those exquisite delicacies which so greatly please a refined mind. It is well to avoid certain errors, which, having fallen into myself, I am anxious that others should not do so; and that is, becoming over critical. I have suffered immensely from presuming to criticise months before I was really competent to do so, instead of setting myself at endeavouring to learn and appreciate beauty. We are, perhaps, all apt to do this. If, for example, a person shows me a beautiful piece of engraving, I confess that I know nothing about it; I might form an idea of the ornamentation, but of the merits of the engraving I could not judge. A great help to our correct study of such subjects is the procuring standard works of real excellence, and trying to learn to understand their principles. It is for want of the possession of such principles of taste, that persons will take up a work of great merit and pronounce it to be very poor. In this manner persons are betrayed into false judgments in relation to ornamentation. I have known persons take some beautiful production, say, of such a man as Owen Jones, the most distinguished ornamentalist alive, and pronounce it very bad. Whereas they knew nothing about it, and were as incompetent to give an opinion upon its beauties or defects, as I should be to pronounce an opinion upon one of the most refined pieces of music. In looking at the works of such a man we must remember that for his own credit sake he would not turn out any thing very bad. It must possess some peculiar merit, because the mind of the author is so refined that he could not produce any thing, as some persons might describe it, intolerably ugly. As I have said, one of the finest specimens of his genius is St. James's Hall, which, as long as it lasts, will be a great monument of Owen Jones.

A word or two upon the importance of ornamentation. The value of an article very frequently depends, almost exclusively, upon its enrichment and beauty. This, for instance, is to a certain extent true of the decoration of a watch. But, let us first take as an example, the raw material of clay. It can be wrought up into an ugly flower-pot, perhaps of the value of one penny; but, on the other hand, it can be wrought up into forms of the most exquisite beauty,

which will fetch from £1 to £20, or even cases of the most exquisite skill, of some hundred of pounds. It is a fact, that in some cases, a sixpenny article will take much more time and labour in manufacturing than that which will fetch a guinea in the market; because the one has been fashioned by a cultivated, skilled, and refined mind, and the other by a workman of uncultivated taste. I remember a good illustration of this fact, although it may not be a good case to show the value of ornamentation. Mr. Wornum, the keeper of the National Gallery, when lecturing upon ornamentation, referred to the commercial value of ornamentation. He took up a plain marmalade jar, without any decoration upon it, and said, "One pound of the best Dundee marmalade in that jar sells for sixpence;" then he produced a second, which had some little appearance of beauty; it had a thistle embossed upon it. The lecturer remarked, "One pound of the best Dundee marmalade in that jar sells for ninepence, the difference in cost of manufacture between that and the former amounts to but one halfpenny." He took up a third jar, which was ornamented with orange blossoms, and said, "One pound of the best Dundee marmalade in this jar fetches one shilling, and the increased cost of production is only one halfpenny more than the last specimen." That fact will serve as an illustration of the commercial value of ornamentation.

In studying nature, seek from its principles of beauty, but never imitate its productions merely, if you wish to achieve beauty in decoration; mere imitation does not rise to the dignity of ornamentation. You must remember what I have just said, namely, that it is necessary to have the mind impressed upon every thing. If you want mere imitation, a photographic apparatus will effect your purpose much better than human skill; but if you want beauty let us go to nature; find out her principles, and then apply them to our own purposes.

The chief part of the remainder of my time this evening I shall devote to the illustration of the principles of vegetable growth; next week I shall endeavour to apply these principles to ornamentation. Plants must be admitted to be the ornaments of nature; they are nature's ornamentation. Generally speaking, we admit that plants constitute the type of natural ornament. Let us therefore examine into the principles which are manifested in the development of plants.

The first feature in plant growth, to which I wish to direct your attention, is the law of repetition. I could illustrate this principle in several ways, but I can do so very easily by reference to a diagram before you, which is a representation of the bryony from our hedges. Some call it mandrake, which, however, botanists know to be a plant of a very different nature. [The Lecturer here referred to his diagrams.] You observe, that as the stem winds along it gives off leaves, which you discover on closer application to have this peculiarity, simply repetition. If you cut the stem across here and here, we find it separated into parts similar to each other. If I take this piece of a broom stick, and let it represent such a stem as I have here, I could build up three distinct parts of the same description. Here is a rough representation of a stem upon which I have now built up various parts similar to each other. You notice that every portion is similar to each other portion. That is the exact plan upon which all plants grow. If I take this little sprig of pimpernel, growing abundantly amongst corn and in our gardens, well known by the fact that its little scarlet flowers close at the approach of rain, for which reason it is called "The Shepherd's Weather Glass," we notice that the leaves are given off in pairs; but we are also struck by this fact, that if we cut it here and here we shall divide it into similar parts again, not possessed of one leaf, as in this and former instances, but of two, as here represented. Here is one unit, and there is another; and now go on throughout the whole plant, no matter how long, not only does every stem consist of parts repeated, but the whole plant is only a repetition of units.

This specimen will give you an idea of the same thing. Here is a little root; there a stem; there little buds on the summit of the stem, and here are two buds, one at either side. Let us mark what will take place next year. In winter, the leaves will have fallen; next spring, we enter on another change, and the buds grow out thus. Here you notice that the plant is simply repeated again; the positions of each being similar to the one which existed last year. If we follow the little branch downwards, we notice at the portion pulled downwards here, that this portion was the root; that this other portion was given out. Here a stem, or something of the kind, has interrupted the growth. That represents what has taken place in a plant two years old, as an example of repetition or multiplication of what the plant was when it was one year old. It may be said to be three plants grown together; that is really what it is.

If the plant produces seeds it only multiplies itself; for if you take any seed, it does not matter what, of common trees—

I should use any grass or corn seed—you will have the same thing. You can see it in the oak, for instance. Get an acorn; take off the skin very carefully, which you can do safely after soaking it in warm water for some little time, and then you will find the seed, which if you wish to set you must invert, for it is the wrong way upwards. You will find that you have a body of this kind. If you have soaked the acorn in warm water for some little time, you will be enabled to pull these portions apart. These are two leaves, unlike as they may seem to be to leaves. They are the first leaves which are produced by the embryo plant. They are what we commonly term the halves of seed, but they are really the seed. The growth of that will only be a repetition of parts similar to what the other produced. This is the first unit, and growth will repeat another.

(*To be continued.*)

ELEMENTARY PAPERS

ON MECHANICS AND MATTER IN MOTION.

(*Continued from page* 96).

ON THE PENDULUM—*continued.*

If the pendulum and escapement are removed from the clock, there would be nothing to prevent the train of wheels from being turned round with great rapidity, by the weight or spring acting on it; and the weight would speedily run down. On the other hand, if the weight or spring cease to act, the oscillations of the pendulum soon come to an end. The rate of movement of the wheels is entirely controlled by the pendulum; thus, to the same clock we might attach a pendulum vibrating seconds, or one vibrating half-seconds; and its rate, the weight being the same, would be twice as great in the latter case as in the former, since the teeth of the escapement wheel are allowed to pass twice as fast. An addition to the weight will not make the clock go faster, but slower; for it will give a slight additional impulse to the pendulum at each oscillation; and this, making its swing greater, will increase the time which it occupies. The application of the pendulum to clocks, as the regulator of the movement of the wheel-work, was first made by Huyghens, about the year 1657. Previously to that date, the pendulum had been employed in astronomical observations, to measure small periods of time, such as those in which the sun and moon traverse a space equal to their own diameters; but no means had been devised for keeping it in continued and regular action.

It is a matter of great importance to determine with perfect accuracy the length of a pendulum vibrating seconds; that is, to ascertain the distance between its centres of suspension and oscillation. This is different at different parts of the earth's surface, in accordance with their varying distances from its centre; and if the length of the pendulum vibrating seconds in each place can be ascertained, it gives very important assistance in the determination of the figure of the earth. Even a comparatively small distance between two places will make a decided difference in the length of the pendulum vibrating seconds at each. Thus at London, which is in lat. $51\frac{1}{2}^\circ$, the length of the seconds pendulum is estimated at 39·13929 inches, whilst at Unst, in the Shetlands, lat. $60\frac{3}{4}^\circ$, the length (owing to the greater attraction of the earth as we approach the Poles) must be increased to 39·17146 inches, for the vibrations to be performed in the same time. The difference may be more easily understood by comparing the number of vibrations which the same pendulum will make in a given time at the two places; for a pendulum which vibrates 2·390 times within a certain period in London, will vibrate 2·391 times in the period at Unst, so that it would gain about a second and a half in the 3,600 oscillations which the second's pendulum makes in an hour.

In fixing our standard of measure, it is of great importance to be able to connect it with some known length; which, if the standard should be lost or injured, may enable us to replace it. Thus, in Britain, all our measures of length were determined by a standard kept in the Houses of Parliament, which was destroyed when they were burned; and, if an accurate copy of this had not existed elsewhere, the standard would have been altogether lost. The only way of replacing such a loss would be, by having previously ascertained the proportion which the standard bore to some natural quantity, which could be accurately measured, and which always remains the same; so that, by reference to this, the standard might be reconstructed. The French government have taken, as their natural standard, the distance from the pole of the earth to the equator, or a quarter of the whole circumference measured on the meridian line; and of this, the ten millionth part constitutes the mètre, the standard from which all the French weights and measures are computed.

ks from the centre of suspension.

advantageous for the two pendulums to be

nearly, but not quite, the same length; and one is hung exactly in front of the other, so that it can be seen whether they pass the same parts of their beat together or separately. Let us call the two pendulums A and B, and suppose that A is vibrating seconds, whilst B is oscillating rather faster. If, now, both pendulums be set in motion at the same instant, and be looked at in front, B will be seen to gain a little upon A at each oscillation, and at last it will be moving one way whilst A is moving the other, having gained half a beat; after as many more beats, it will have gained as much more, and will recommence at precisely the same time with A, having performed one more oscillation in that interval. That coincidence will be only for a moment; since in the very next beat B will have gained a little upon A: but it will be repeated again and again, after every similar number of beats. It is not requisite to count the number which intervenes, but merely to ascertain how many coincidences take place in a given time as shown by the clock. Thus, suppose that ten coincidences are observed in one hour, during which A (the seconds pendulum) makes 360 oscillations; then for every 360 oscillations there will have been one coincidence, indicating that B has performed one oscillation more than A in that period. If B be longer than A, and its oscillations be slower, precisely the same principle applies; but the number of its vibrations is then one less than that of A, for every coincidence.

When the rate of a pendulum and its virtual length have thus been ascertained, the length of the seconds pendulum is easily calculated by the following proportion: as the square of the time of the one pendulum is to the square of the seconds pendulum, so is the ascertained length of the one pendulum to the length of the seconds pendulum. When the latter has been determined by a common rule of three sum, there are still many corrections to be applied to it, in order to rectify it for the purpose of serving as a standard. Thus, the height of the place of observation above the level of the sea may make a sensible difference in the result; and in order that observations made in different places may be compared with each other, it is desirable to reduce them all to an uniform standard—the sea level. Again, the density of the air is so different at different times, and as its resistance acts so differently on pendulums of different forms and materials, a correction must be made for it; and here, too, it is most convenient for the comparison of observations made under different circumstances, that they should be all corrected so as to represent the length of a pendulum oscillating in a perfect vacuum. This correction can be made by calculation, founded on the form and density of the pendulum. The result of these calculations has been to make the length of the seconds pendulum, in latitude of London, 39·13929 inches; and this has been declared by act of parliament to be the standard of measure. It was intended that, in case of the standard being lost, destroyed, or injured, the new one should be constructed by the natural one thus obtained;—that is, if the length of a pendulum vibrating seconds were divided into 3,913,929 parts, the standard yard should be 3,000,000 of those parts. It is doubtful, however, whether this determination of the length of the pendulum is accurate; and it has been stated on high authority, that if a new standard were constructed from it, this would differ sensibly from the old one. It appears that there are sources of error which had not been suspected; and these should impair our reliance on the perfect accuracy of the experiments hitherto made in this country. The latest, and probably the most accurate series of such experiments, is that made at Konisberg by the celebrated astronomer Bessel; the result of these gives as the length of the seconds pendulum, in 54° 13′ north latitude, 440·8179 French lines, which is equivalent to about 39·1593 English inches. There is not much difference, however, between this estimate and that of Captain Kater, for a corresponding latitude.

Religion and Clock-Making.—However widely differing and entirely unconnected the above subjects may appear, yet if sought into they would seem to have some connection. It was in monasteries that machines for the measurement of time were first invented; and to the labour of these monks horology stands much indebted. The earliest mention of any instrument by which the flight of time could be appreciated is in the book of a prophet (*a*) The invention of clocks is generally ascribed to a pope ;(*b*) but some give the honour to an archdeacon (*c*). Who has not heard of the celebrated clock made by the Abbot of St. Albans? Who has not heard of the Fathers Schott, Kircher (*d*), Truchet (*e*), Alexandre (*f*), Vailly (*g*), &c.? Thiout, the author of two volumes of horology (*h*), was Vicar of St. Cyr; and Derham, the author of the "Artificial Clockmaker" (*i*) was a clergyman.

(*a*) The dial of Ahaz. *Vide* Isaiah xxxviii., 8.
(*b*) Gerbert, who was pope under the title of Silvester the Second, A.D. 996.
(*c*) Pacificus, Archdeacon of Verona, A.D, 815.
(*d*) Schott and Kircher, great mechanical geniuses; they flourished in the sixteenth century.
(*e*) A celebrated constructor of automata. *Vide* Memoirs of Roy. Acad. des Sciences, 1729.
(*f*) Author of Traité General des Horloges. 8vo., Paris, 1734.
(*g*) Inventor of the modern clepsydra.
(*h*) Traité d'Horlogerie, &c. Paris, 4to, 1741.
(*i*) This little work has gone through seven English editions, and is also published in the French and German languages.

A BRIEF DESCRIPTION OF

THE ASTRONOMICAL CLOCK OF THE CATHEDRAL OF STRASBURG.

BY CHARLES SCHWILGUE.

(*Strasburg*, 1844.)

PART I.

Of the Ancient Clocks of the Cathedral of Strasburg.

The first clock set up in the interior of the Cathedral at Strasburg, was begun in 1352, and completed two years afterwards, under John Bishop of Lichtenberg. It was placed in the double transept opposite to the place of the present clock. There is still to be seen at the present day, in the wall, the brackets which served to support it.

This clock, the case of which was entirely of wood, consisted of a calendar like those in use at that period, representing in a painting some indications relative to the principal moveable feasts. By the side of this calendar, formed of a large disc of wood, there was hung a picture, upon which were read in German rhymes the wondrous properties which our credulous ancestors attributed to the seven planets.

In the middle part there was an astrolabe, whose pointers showed the movements of the sun and moon, the hours, and their subdivisions. There was placed at the same elevation the prime mover, and the other wheel work which caused the clock to go. The upper compartment was adorned with a statuette of the Virgin, before which, at noon, the three Magi (wise men of the East) bowed themselves. An automaton cock, placed upon the crown of the case, crew at the same moment, moving its beak and painfully flapping its wings.

A small set of chimes, composed of several cymbals, formed besides a part of this work, of which, notwithstanding all our enquiries, we have not been able to find the name of the author.

The second clock dates from 1547. The project had for its authors, Doctor Michael Heer, his friend Nicholas Bruckner, and Christian Herlin, professor at the University of Strasburg and one of the most distinguished mathematicians of his time. These learned men joined with them several intelligent artists and workmen. Unfortunately the death of the colleagues of Herlin, and the untoward events of the period, arrested the execution of the work. This interruption happened at the moment when the mathematicians had just finished the design of the astrolabe, when the stone cutters were putting the finishing stroke to the chamber which serves still for the present clock, and when a finish had been already put to the iron cage destined to receive the mechanism of the clock. The works remained suspended till 1570; from that time at the invitation of the managers of the Œuvre Notre-Dame, the undertaking was recommenced by Conrad Dasypodius (Rauhfuss), a disciple of Herlin, and his successor in the chair of mathematics at the University of Strasburg.*

While profiting by some of the parts which were completed, this learned man did not follow the plan of his predecessors; he reconstructed it upon a larger scale, and did not begin the work till after his project had received the approbation of several distinguished professors, among whom were the celebrated mathematician Oswald Schrekenbeufuchs of Friburg.

The mechanical works were confided to two brothers, Isaac and Josiah Habrecht, clock-makers of Schaffhausen in Switzerland, who had already acquired some renown, one by the construction of an astrolabe, the other by that of a sphere. Tobias Stimmer, one of their fellow-citizens, was employed to do the paintings and the sculptures which were to serve as decorations of the achievement. Hardly had the association been formed, when Dasypodius, succumbing under the weight of his toilsome and numerous works, found himself under the necessity of associating with himself his

* Conrad Dasypodius was born at Strasburg in 1531, being the son of Peter Rauhfuss, a learned Greek scholar, of Frauenfild, in Switzerland, and who, between 1547 and 1559, had changed his German name (literally *hairy foot*) into the Greek one of Dasypodius. which has the same meaning. Conrad Dasypodius showed an early liking for mathematics, which his father, although himself a Hellenist, or lover of Greek, spared no pains to encourage; his first master in this branch of knowledge was the celebrated Herlin, who conceived an affection for him, induced him to enter into holy orders, and kept his own chair in reserve for him, and in which Dasypodius succeeded him in 1562; the same year he was likewise named a canon of the chapter of St Thomas. The reputation of Dasypodius dates from 1566, at which period he published his "Commentaries on the First Books of Euclid," which on their first appearance caused a great sensation. He gave a description of the astronomical clock of the cathedral in his "Heron Mathematicus, Argent, 1580." Subsequently to his having been made Warden (Custos) of the Chapter of St. Thomas, by Bishop Jean de Nanderscheid, he was, in 1531, made Dean of the same Chapter by the votes of his colleagues. He had designed the collection and publication of the Greek mathematical writers, when death cut short his great undertaking; and he died 26th of April, 1601, at nearly 70 years of age.

friend David Volkenstein, astronomer of Breslau, whom he sent for from Augsburg, where he was then teaching the exact sciences.

It was due to the active co-operation of these diverse talents that this work, so impatiently waited for, performed its duties for the first time on the 24th of June, 1574, the day of St. John the Baptist. The mechanism of the clock was not entirely finished, when Josiah Hábrecht, the younger of the two brothers, was sent for by the Archbishop-elector of Cologne, to construct an astronomical clock in the castle (chateau) of Kayserswœrth. This journey and the illness of one of his sisters who became blind about the same time, appear to have given birth to the famous popular tradition, which imputes to a magistrate of Strasburg the odious crime of having put out the eyes of the author of the astronomical clock of the Cathedral, to prevent him from making another like it.

This clock—restored a first time in 1669, by Michael Isaac Habrecht, grandson of Dasypodius (one of the original makers), a second time in 1732, by James Straubhaar, a kinsman and successor of the same Habrecht—ceased to act in 1789.

The body of the wheel-work, as well as the other parts of this clock, after having been finished have just been remounted in the chapel of (L'Œuvre Notre Dame) the Virgin.

After these first-mentioned historical sketches, it remains for us to make known the labours of Dasypodius and of the Habrechts. This clock was surrounded at first by a wooden ballustrade, breast high, then by an iron railing, whose bars, in the shape of lozenges, intercepted the view; a part of this railing, about two metres high, has just been placed in the north transept, around the baptismal font executed in 1453, after a design of the architect Iodoque Dotzinger.

Before, and at the foot of the clock, there was a celestial globe supported on four columns of wood very richly carved. This globe, formed of a mixture of paper, chalk, and glue, weighed about 50 killogrammes.* It performed a revolution on its axis, showing the stars known in the time of Ptolemy, about A.D. 140. These stars, to the number of 1020, were grouped in 48 constellations, represented by as many beautiful figures. Two circles, one carrying the sun and the other the moon, turned round the globe, the first in 24 hours, the second in the space of about 25 hours.

Immediately behind the celestial globe, there was a large wooden disc in which was painted a calendar for the space of a century, the months, the days, the dominical letter, the names of the saints, and the dates of the principal moveable feasts. This calendar, of which one of the least defects was to make all the years bissextile, or of 366 days, made an entire revolution every year. The statues of Apollo and Diana, placed on two sides of the disc, pointed out with their sceptres, the one the day of the year, the other the corresponding day at the end of six months. The central part of the calendar was immoveable, on it were represented the countries of Germany situated along the Rhine, and the topographical plan of the city of Strasburg. There were on the same part the names of the learned men and of the painter who joined in executing that portion of the work.

The compartments situated on the two sides of the calendar were occupied by the large pictures upon which were painted the principal eclipses of the sun and moon visible in the northern hemisphere, and answering to an interval of thirty-two years only, that is to say the period from 1573 to 1605. These pictures, which were fixed in a way that they might be removed, were replaced by two others showing the eclipses from 1613 to 1649, which were not renewed after that period. Made in imitation of the first ones, these pictures merit our attention as much from the expression of the painting and the richness of the details, as from the original manner in which the eclipses are represented on them.

Above the calendar there were seen in the clouds the seven pagan divinities that have given their names to planets, and afterwards to the days of the week. These allegorical figures, seated in chairs drawn by the divers animals which mythology assigns to each of these divinities, showed themselves successively on the days which were sacred to them.

On Sunday, Apollon was seen; this day being dedicated to the sun, the ancients name it *dies solis* (the day of the sun), and the Christians the Lord's day (dies Dominica), whence is made the French word, *dimanche*, for Sunday. Diana showed herself on the second day, which was called *dies luna* (day of the moon)—Lundi—Monday. Mars, the god of war, appeared on (Mardi) Tuesday, the English word being derived from *Tuesco* the Saxon name of the god of war. The fourth day was represented by Mercury, the messenger of Olympus; French, Mercredi; English, Wednesday (the latter being derived from *Wodin*, the Saxon name of the same

* 110¼ lb. nearly

deity). The following day *dies juvis*, Jupiter's day; French, *Jeudi;* English, Thursday, (derived from *Thor* the Saxon name for Jupiter). The beautiful Venus showed herself on Friday (which in English is derived from *Friga*, the Saxon name of the goddess Venus). Last of all, Saturn, the god of time, came on Saturday to close the Olympian procession.

Immediately above the divinities of the week was a gallery, the middle was occupied by a small dial plate which indicated the quarter-hours and the minutes, the hours being represented upon the astrolabe, as we shall see; at the sides of the dial plate were seated two genii, of which, the one placed on the right raised a sceptre each time the hour was to strike, and of which the other at the same moment turned upside down an hour glass which he held in one hand, turning it always in the same direction. An astrolabe, constructed according to Ptolemy's system, occupied the greater part of the middle story, in the interior of which was contained the wheel-work of the clock. Six pointers, bearing the same number of planets, pointed out, upon twenty-four divisions of the astronomical day, the movements of these heavenly bodies; one pointer, larger than the others and terminated by a sun, finished in twenty-four hours an entire revolution round a small map of the world placed in the central part of a large dial plate, which was ornamented at the same time by the circles of a horoscope and by the twelve signs of the zodiac.

The upper part of the astrolabe was crowned with the phases of the moon. There was visible a small dial-plate cut in its lower part by two semi-circles, behind which the moon, represented by a gilded disc, disappeared at the time of the new moon, and came out from day to day to show successively a quarter part of its orb, till it presented to view its entire disc, at the time of full moon.

At the third story of the clock there was a platform of wood placed horizontally, upon which were fixed four small statues representing the four ages (periods of life)—infancy, youth, manhood, and old age; these figures struck the quarter-hours upon cymbals.

Above this platform was suspended the bell intended for sounding the hours. Two figures stood beside this bell, the one was Death under the form of a skeleton, the other represented Christ having in one hand the cross and the palm branch. At the instant the hour ought to strike, the Saviour came forward, and the skeleton drew back; but hardly had this movement taken place when Christ retreated precipitately, and Death advanced in the same way to strike on the bell the number of strokes required. This unpleasant movement was repeated as many times as there were strokes in the hour.

The turret, placed on the left of the principal edifice, contained the weights of the clock, as well as the machinery intended for the cock which was perched on the summit of this turret. This cock (the only piece which was preserved from the first clock, called the clock of the three kings) crowed at first daily, at noon, flapping its wings and opening its beak; but having been struck with lightning in 1640, it was not made any longer to crow, except on Sundays and feast days. It ceased crowing entirely in 1789, at the time when overwhelming attention bestowed upon the great events that were taking place caused it to be completely forgotten.

This clock, which represented the state of knowledge of the sixteenth century, was, for the period, a real master-piece; hence it was reckoned among the seven wonders of Germany, of which Strasburg then formed a portion, as a free town. The most emminent poets of the period, as Xylander, Fishart, Crusius, Cell, Frischlinus, &c., vied with each other in making it the subject of their songs, whether in Latin or German.

The following inscription was formerly to be read over the great entrance gate of the metropolitan church of Mayence:

SEPTEM GERMANIÆ SPECTAMINA:
TURRIS ARGENTINENSIS:
CHORUS COLONIENSIS:
HOROLOGIUM ARGENTINUM:
ORGANUM ULMENSE:
NUNDINÆ FRANCFORTENSES:
MECANICA NURENBERGENSIS:
STRUCTURA AUGUSTANA.

Translation.

The Seven Wonders of Germany were:—

1. The Tower of Strasburg.
2. The Choir of Cologne.
3. The Clock of Strasburg.
4. The Organ of Ulm.
5. The Fairs of Frankfort.
6. The Mechanism of Nuremburg.
7. The Guildhall of Augsburg.

(*To be continued.*)

INTERNATIONAL EXHIBITION, 1862.

DECISION OF HER MAJESTY'S COMMISSIONERS ON POINTS RELATING TO THE EXHIBITION.
MARCH, 1861.

Her Majesty's Commissioners have fixed upon Thursday, the 1st day of May, 1862, for opening the Exhibition.

The Exhibition Building will be erected on a site adjoining the gardens of the Royal Horticultural Society, and in the immediate neighbourhood of the ground occupied in 1851, on the occasion of the first International Exhibition.

The portion of the building to be devoted to the exhibition of Pictures, will be erected in brick, and will occupy the entire front towards Cromwell-road; the portion in which Machinery will be exhibited will extend along Prince Albert's-road, on the west-side of the gardens.

All works of industry to be exhibited should have been produced since 1850.

Subject to the necessary limitation of space, all persons, whether designers, inventors, manufacturers, or producers of articles will be allowed to exhibit; but they must state the character in which they do so.

Her Majesty's Commissioners will communicate with Foreign and Colonial exhibitors only through the Commission which the Government of each Foreign Country or Colony may appoint for that purpose; and no article will be admitted from any Foreign Country or Colony without the sanction of such Commission.

No rent will be charged to exhibitors.

Prizes, or rewards for merit, in the form of medals, will be given in the Industrial Department of the Exhibition.

Prices may be affixed to the articles exhibited.

Every article produced or obtained by human industry, whether of

Raw materials
Machinery
Manufactures, or
Fine Arts

will be admitted to the Exhibition, with the exception of

1. Living animals and plants.
2. Fresh vegetable and animal substances liable to spoil by keeping.
3. Detonating or dangerous substances.

Spirits, or alcohols, oils, acids, corrosive salts, and substances of a highly inflammable nature, will not be admitted, unless sent in well-secured glass vessels.

The articles exhibited will be divided into the following classes:—

SECTION 1.

CLASS 1. Mining, Quarrying, Metallurgy, and Mineral Products.
„ 2. Chemical Substances and Products, and Pharmaceutical Processes.
„ 3. Substances used for Food, including Wines.
„ 4. Animal and Vegetable Substances used in Manufactures.

SECTION 2.

CLASS 5. Railway Plant, including Locomotive Engines and Carriages.
„ 6. Carriages not connected with Rail or Tram Roads.
„ 7. Manufacturing Machines and Tools.
„ 8. Machinery in general.
„ 9. Agricultural and Horticultural Machines and Implements.
„ 10. Civil Engineering, Architectural, and Building Contrivances.
„ 11. Military Engineering, Armour and Accoutrements, Ordnance, and Small Arms.
„ 12. Naval Architecture, Ship's Tackle.
„ 13. Philosophical Instruments, and Processes depending upon their use.
„ 14. Photographic Apparatus and Photography.
„ 15. Horological Instruments.
„ 16. Musical Instruments,
„ 17. Surgical Instruments and Appliances.

SECTION 3.

„ 18. Cotton.
„ 19. Flax and Hemp.
„ 20. Silk and Velvet.
„ 21. Woollen and Worsted, including Mixed Fabric generally.
„ 22. Carpets.
„ 23. Woven, Spun, Felted, and Laid Fabrics, when shown as specimens of Printing or Dyeing.
„ 24. Tapestry, Lace, and Embroidery.
„ 25 Skins, Fur, Feathers, and Hair.
„ 26. Leather, including Saddlery and Harness.
„ 27. Articles of Clothing.
„ 28. Paper, Stationery, Printing, and Bookbinding.
„ 29. Educational Works and Appliances.
„ 30. Furniture and Upholstery, including Paper hangings, and Papier-mâché.
„ 31, Iron and General Hardware.
„ 32. Steel and Cutlery.
„ 33 Works in Precious Metals and their imitations, and Jewellery.
„ 34. Glass.
„ 35. Pottery.
„ 36. Manufactures not included in previous classes.

SECTION 4.

„ 37. Architecture.
„ 38. Paintings in Oil and Water Colours, and Drawings.
„ 39. Sculpture, Models, Die-sinking, and Intaglios.
„ 40. Etchings and Engravings.

Her Majesty's Commissioners will be prepared to receive all articles which may be sent to them, on or after Wednesday, the 12th of February, and will continue to receive goods until Monday, the 31st of March, 1862, inclusive.

Articles of great size or weight, the placing of which will require considerable labour, must be sent before Saturday, the 1st of March, 1862; and, manu-

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gloomy at 9 a.m., overcast with squalls of hail and rain throughout the day, and blue sky and clouds at night.

On 1st at 3 p.m., bar. was 29·603, wind wsw, force 7, with much rain.

On 9th at 10 a.m., bar. was 30·453, being the highest observed during the month.

On 11th at 5 p.m., bar. was down to 29·289 with rain.

On 16th at 11 p.m., the mercury stood at 30·044, and from this time it continued to fall till the 19th at 9 a.m., when the lowest reading was observed (see table). During this interval the weather was very changeable, with moderate gales of wind from ssw, w, and nw.

On 20th at 7 p.m., bar. was 29·305, wind ssw, force 9, with heavy squalls and much rain; and at 11 p.m., it had moderated to sw, force 4, with a misty blue sky.

The mean temperature for March being 41° it will be observed that the temperature has been above the average throughout the month; the continuance of westerly winds accounts for this.

From an interesting table of "English Rainfall in 1860," compiled by G. J. Symons, Esq., the following has been obtained. During the year just passed, 1860, the total fall of rain at Camden Town, amounted to 32·24 inches; at Ryde, Isle of Wight, 36·28; at Bedford, 24·95; at Torquay, 36·36; at Penzance, 49·25; at Bristol, 42·96; at Gloucester, 28·01; at Manchester, 36·14; at Wakefield, 33·48; at Scarborough, 24·00; at North Shields, 32·19; at Carlisle, 31·63; at Ambleside, Westmoreland, 79·97; at Ballasalla, Isle of Man, 37·17. The elevation of all these places being about 100 feet above the sea; they will therefore serve to shew the distribution of rain over England. Rain was in excess of the average of previous years at nearly all the stations. R.S.

TO CORRESPONDENTS, &c.

All Communications for this Journal should be addressed to the Editor, *at the Office*, 35, Northampton Square, Clerkenwell.

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BRITISH HOROLOGICAL INSTITUTE.

BOTANY, AS APPLIED TO ORNAMENTATION.

By Dr. C. Dresser, F.L.S., F.E.B.S.

The First of Three Lectures, *delivered to the Members of the* British Horological Institute, *on the Evening of the 7th February,* 1861.

Mr. J. F. Cole, V. P., in the Chair.

(*Continued from page* 108).

I could extend these remarks to a very great length with much advantage; but I am so pressed for time that all I can do is to throw out hints, and leave you to work them out for yourselves. Here is another class of repetition; the flower consists of a certain number of parts repeated. Here upon this diagram is a repetition of similar parts, but they are radiating from the centre. I wish to get clearly into your minds this idea of repetition, which is the great clue to the principle of all plant growth. If the stem is elongated it is only by producing another repetition. Had we time we might even shew that when plants produce blossom it is only repetition; for it is only a branch in a modified condition.

It is of great importance that I should call your attention to the principle of order manifested throughout the vegetable kingdom. When we wander through the fields we are struck with what we suppose to be the freeness of nature. We see the birds soaring up into the air, and think how free they are. As we see them stand chirping upon the hedge we think that they are bound by no laws, but that all is perfect freedom without restraint. It is not so however; remember that everything in nature is under the government of law. The leaf may seem to grow where it pleases, but in reality it is not at all so. We must never be hasty in pronouncing judgment upon plants, for we may not in all cases at first sight be enabled to detect the principles of order manifested; but do not for one moment conclude that there is no principle of order, because it is not apparent at first sight; that is an erroneous notion, which we must ever especially guard against. There may be a principle of order so refined and concealed that we may not at once detect its presence, but whether there is a manifestation or not it yet exists. The recent labours of scientific men have discovered that there is not such a thing in the vegetable kingdom as one leaf produced from a stem by accident, or one branch proceeding from another except upon certain fixed principles.

I can shew you this principle in one or two ways. If we take a branch of elder, like this I have depicted upon my diagram, it will present the same peculiarity; the leaves grow in units; but if we take another we find they grow in pairs. There is a sort of order about it. They always grow in pairs, except some peculiar accident happens, and then the pair cross one another and are developed there. One piece of the root is left, and the next pair will be developed there. One will advance, while the other recedes, so that successive pairs cross one another in this manner, so that you see at once a principle of order. If we take a little plant, well known to us all, called the "goose grass," and by country children "whip tongue,"—a little rough plant which grows by common hedges; called so by reason that it catches the stem of little plants, and is furnished with many minute hooks which the country children put to their tongues, and say, that it whips the skin off them—you will find in it a number of leaves growing on leaves, some five, six, or eight, forming a ring round the stem.

Let us pass to some other specimens which, perhaps, present greater difficulties. Here is a stem of grass; here there seems to be a species of order; not one leaf rising here and another at the root. We see in this bigonia one advanced root, and the next root, and so on. That is the most simple illustration which I could give you of a principle which becomes more complex, until we are led out to a wonderful extent which ends only in the infinite. Let me endeavour to illustrate this position by this model. Notice, that I have placed round this cylinder, a line which represents the spiral line or thread of the stem of a plant. If you look on the top you see two rows of leaves. I will draw two lines down the cylinder, one on either side, to represent the two rows of leaves. This part of the line crosses this spiral thread, or, rather I would say, that this spiral thread crosses this part of the line. I place here a dot where the first leaf grows. Following the spiral, and onwards, here is

the second line crossing, and from there another leaf grows. Following onward, we come to a third crossing of the line, and then we reach the first leaf over one of the former; this is over the first with which we started, so we call that one again; then we pass on to leaf two, which again is over the first number two; then we come to the third, and so on throughout the leaves. Some one —I do not know who—has invented a most ingenious method of representing this in a very simple manner. He represented this range of leaves by the fraction $\frac{1}{2}$, answering to one turn of the spiral thread. Starting here, we pass once round and reach here, going round this once you reach number one and two leaves. Then, again taking another turn of the thread round the stem, we meet with two leaves, which are one half the circumference of the circle from one another, and also two rows of leaves represented by this figure 2. The next step in the complexity of arrangements, is three rows of leaves in place of two; that is the only difference; so that in a spiral line passing once around the stem, near it again we meet with three leaves; which arrangement we represent by the fraction $\frac{1}{3}$, in which each leaf is one-third of the circumference of the circle from the consecutive leaves. Another arrangement is represented by the fraction $\frac{2}{5}$. This mode of leaf-development differs from those which I have already explained in this particular, that in the last instance one turn of the spiral thread meets with three leaves, but in this instance, we have to go twice round the stem before we meet with a leaf developed over the one from which we started, and in doing so, we meet with five leaves. This spiral arrangement of the foliar organs is a principle of great importance in plant growth. This is an arrangement which we meet with in the apple, the plum, the cherry, and in fact in all fruit trees, as well as in the rose and a number of other instances.

It is impossible to get a view round some arrangements. This is a plant viewed upon the summit. If we look upon this $\frac{2}{5}$ arrangement from the top branch, we get this spiral, which some gentleman suggested to me as being your watch spring, but which I do not know anything about. It is my plant spring arrangement. Here we have a representation of a large spiral, but instead of five rows, as in the last instance, we get thirteen. All little plants, such as the dandelion, differ from this; they have very short stems; instead of having five there are thirteen, which will be represented by the fractions $\frac{5}{13}$. We shall have to go five times round before we find a leaf over the one with which we started, and each leaf is five thirteenths of the circumference of the stem from those which precede and follow it.

What I have now said is enough to establish the fact that a system of order is discoverable in plants, and that every leaf and stem arrangement which appears complicated is only apparently so, because we are not familiar with the spiral disposition of the leaves. It is easy by following this rule for the botanist to discover at once the arrangement of the leaves. There is a number of particulars connected with this law which are of great interest. There is a singularity in the numbers which I have just pointed out. The first fraction is $\frac{1}{2}$; the next $\frac{1}{3}$; the next $\frac{2}{5}$; the next $\frac{3}{8}$; and the next $\frac{5}{13}$. Notice how they run when you take the numerations:—1 and 1 is 2; 1 and 2 is 3; 3 and 2 is 5; 5 and 3 is 8; 8 and 5 is 13. There are many peculiarities connected with these numbers which could be pointed out, and which you will find pervading all nature.

There is another feature of considerable importance in plant growth, which we call the law of alternation. If we looked down upon the top of these plants, we should find the leaves formed of four rows. We just noticed a pair of leaves crossing one another. The leaves of one are developed to the right, and the next to the left, and some may be crossed or alternate. Look at the flowers; they generally consist of a ring or vertical of green parts; a ring of coloured leaves; a ring of little thread-like bodies terminating in knobs, and a central arrangement; but the red leaves are on the rose, whereas green leaves are here. The one is not near the other; but every successive ring alternates. Here is a green ring, and here a coloured ring; and the fruits of the latter fall between the green ones; then the next ring falls below the last. This principle of alternation runs throughout the whole of the vegetable structure. Wherever it is, there is symmetry. From what we have said, it is obvious that a sort of mathematical basis runs through, or constitutes the foundation of, all plants. There are three classes of symmetry in plants. Here is the flower. A great majority of flowers are constructed on this type, there are a number of similar parts arranged in a regular manner. We have a multitude which have the halves alike, such as the violet and pansey, which do not consist of a number of similar parts radiating from a centre in the manner that the other does; all its members are not alike, but the halves only. We have to deviate from the spiral arrangement in those we have spoken of, but in all this

there is manifest order; the mind only rests on the symmetry, or the balance of the parts. But there is this peculiarity; take those flowers which have the halves only alike such as the violet where they only cross, and we find from the second line it is always erect. Flowers of this kind are not commonly horizontal. We look down, for instance, on the tops of the sweet William and the pink. It is a graceful position when the halves are alike. You may tell me that there are flowers where the halves are not alike; for instance, the candied-tuft, and a number of plants represented by the parsley and the hemlock, all have the halves unlike. The candied-tuft has large petal leaves; but they are never found alone like the violet, they always have their leaves open towards the centre. Their beauty is restored by their always being arranged in rings with the smaller parts directed upwards. The only apparent exception to symmetry, which occurs in such instances, is in the leaf of the bigonia, where the one half is always very materially larger than the other.

Adaptation is a consideration of considerable importance. It is one of the most beautiful provisions of vegetable growth that plants are always adapted to the circumstances in which they are called to exist. If the earth was a little larger or a little smaller, the plants could not grow upon it. If the same quantity of matter were squeezed into half its circumference, the plant could not live. There are a hundred things which we never think of, but which all evidently prove that plants are exactly adapted to the circumstances in which they are placed. I may take one or two very familiar illustrations. There is a plant, known perhaps to none but botanists, because it is not of English growth, which may furnish us with a good example of this law of vegetable life. It has a singular shaped leaf of that description, with a very curious stalk. This stalk has a kind of bladder, or float, extremely light, with chambers filled with air. It belongs to a water plant, called the pantederia. It does not attach itself to the matter at the bottom of the stream in which it grows, like many plants, but will flourish merely swimming on the surface of the water and washed by the waves; being held up by these float balls, which in fact are its very life. It will, however, grow upon the earth; but when transferred there, this peculiarity is observable as one of the results caused by the change; every fresh leaf generated is without the float in the stalk, because it is no longer requisite; but if you throw it again into the water, being without the float it will sink; but in the course of two or three days, it will have sent out some new leaves with the air bladder attached to the stalk, beneath the lake, and having done so, it will come up to see what is going on above again, being enabled to do so through having regained its floats. If time would permit, I could cite a number of instances of this kind. When the same plants are found growing in other localities we may commonly notice a very material change in them. Plants grown in the valley are very different to those of the same class upon the mountain steeps, which being more exposed to the fury of the tempest, have their stems shorter, stronger, and more woody. Their leaves are more divided, so that the wind can pass through them, without tearing them, and the plant is altogether much better able to withstand the severity of the blast. If we take the pea blossom, a plant which we are very familiar with, we notice a great peculiarity. You will observe, that here is a series of little knobs. If these get wet soon after the flower opens, no seeds can be produced; and the provision made by nature to guard against such a contingency, is extremely curious and ingenious. Take the little harebell, and you find it hangs downwards, like a bell, so as to cause the rain to fall off its sides. The little pimpernel, again, closes when the rain is coming, and thus the parts are kept dry. The daisy has an arrangement which conducts the water off, so that none gets into its little knobs. The pea blossom has also a very singular construction. There is at the top a part like this; something like a ridge tile in the centre of a building. In the pea flower there is a kind of cut in the edge of the upper leaf. Two leaves will be here, and the two lower leaves there. Those little parts, ten in number, occur here. The pod, containing the seed would be here. If it got wet it would bear no seed; but so sensitive is the plant, that whenever the rain comes on it always closes. It opens during the sunshine for a special reason. It is just as necessary for the well-being of the plant, that the bee should gather honey from it, as it is for the bee that it should get it from the flower; it expands, therefore, and the bee comes and removes it. But when the storm is coming on, this little leaf shuts down, and these two leaves are pressed more closely together, the whole is closed in, and the water falls and drips to the ground. Then the whole of the stem is enclosed in a little socket, in this manner. The flowers always turn their backs to the stream. All this shows a marvellous adaptation to the conditions which must be fulfilled.

I will call attention to only one other feature of the adaptation of plants to circumstances, in a more particularly artistic and ornamental point of view. The arrangement of the leaves of the ivy, which grows in an open position, is what we term the $\frac{2}{5}$ spiral. If the plant grows in an open space, it is capable of being viewed on all sides. If the horse chesnut tree grows in the middle of a field, I can walk round it, and see every side of it; but if a plant grows upon a wall, I cannot look through the bricks to see the back. The $\frac{2}{5}$ plant arrangement is adapted for growing against a wall. As soon as the ivy is placed against it, it alters the arrangement of its leaves. It alternately turns the face of its leaves outwards. The very laws which govern its growth bring about this result. The vital principle of the plant is sacrificed to beauty. Take a jessamine leaf and arrange it in this manner. They grow in pairs crossing one another. If two leaves be added to this, and tied to this, the back leaf will clash with the wall; but directly the jessamine is placed in such a position, all the leaves fall over one another, like this.

Had I not exhausted my time and your patience, I might have said a few words about geometrical forms. I will, however, just give you one hint upon them. In viewing the form of the leaf, try and reduce it to its most simple constituents. You can do so in a moment in plant growth, by bringing your minds to bear on geometrical forms. Here is a hexagon, or a six-sided figure, a honey-comb shape. Let the mind ask itself invariably in looking at these figures, or at any ornament, in what do they consist? Perhaps we may learn very little from them at first, but we shall discover a great deal afterwards. This consists simply of a number of triangles. Each figure is thus constituted of three lozenges, or diamonds. If I open this in a certain manner I can turn it into a hexagon; it consists of three diamonds, each one being composed of two triangles, but arranged thus. There are six triangles, with their points radiating from the centre. With the two triangles I get a hexagon; with three a star, which is just two hexagons arranged in a particular manner. Here is a shape of a peculiar character, for this reason, that they will fit into one another. Then we can fit these together, repeat these, and leave spaces between them.

There are a vast number of points which might be mentioned in relation to this subject; but the great thing which I have found it necessary to observe is this:—endeavour to resolve every geometrical form into its most simple condition. Think of all the modes by which such a form could be attained. As soon as you learn that, you have learned a great secret from geometrical forms as ornamental decorations. So soon as you see every means by which the form can be produced, your mind will be so stored with ideas, that you can learn some form or other in infinite variety of modifications, and thus be enabled to observe to an extent which you little dreamed of previously. If you want to study geometrical forms, get a model of the description which I have here. Try and view these forms in all their relations, and depend upon it, you will very soon realize fully the fact that such knowledge is power.

THE ANEROID BAROMETER.

As many of the members of the Horological Institute, and other readers of this Journal, are interested generally in all kinds of philosophical instruments, either as regards their manufacture or their sale, it may not be unacceptable to offer, from time to time, notices of the most scientifically important, with a view of directing attention to the most recent improvements in them, as well as of calling attention to their practical scientific value.

It is only too well known that practical workmen greatly neglect the theories and principles of science upon which the construction and utility of their productions depend. The consequence is great imperfection, or want of accuracy, in the instruments they produce. Then as to the sellers of such instruments, to whom the buying public look for any explanation that may be required regarding them, how often is it found that they are totally unacquainted with the principles of construction, the laws of action, and the mode of practical use of most of the instruments which they vend. Perhaps nothing is more certain, than that the successful sellers of scientific instruments are those who are well acquainted with their manufacture and application. Such a person soon gets a reputation, and buyers will resort to him from the recommendation that he is a person who can inform them regarding the instrument they may require.

We select the *Aneroid* for our present paper. This beautiful and highly ingenious instrument is no less remarkable for the scientific principles of its construction and action, than for the nicety of its mechanism. It is a substitute, and perhaps the best of all substitutes for the mercurial barometer. As its name implies, it is constructed "without

are rendered very evident by a nice me-

composed; and there is the effect on the

elasticity of the small portion of air in the box. An increase of temperature produces greater, a diminution less elasticity in this air. The so-called compensation for effects of temperature must be adjusted by the process of "trial and error," and there is much doubt whether it is generally well performed. Is it not very often a mere sham and delusion? Admiral Fitz Roy in his excellent "Barometer Guide" writes: "The known expansion and contraction of metals under varying temperatures, caused doubts as to the accuracy of the aneroid under such changes; but they were partly removed by introducing into the vacuum box a small portion of gas, as a compensation for the effects of heat or cold. The gas in the box, changing its bulk on a change of temperature, was intended to compensate for the effect on the metals of which the aneroid is made. Besides which, a further and more reliable compensation has lately been effected by a combination of brass and steel bars."

Admiral Fitz Roy's notices of the aneroid are peculiarly good, and we quote still from his "Barometer Guide:" "Aneroid barometers, if often compared with good mercurial columns, are similar in their indications, and valuable; but it must be remembered that they are not independent instruments, that they are set originally by a barometer, require adjustment occasionally, and may deteriorate in time, though slowly."

"The aneroid is quick in showing the variation of atmospheric pressure, and to the navigator who knows the difficulty, at times, of using barometers, this instrument is a great boon, for it can be placed anywhere, quite out of harm's way, and is not affected by the ship's motion, although faithfully giving indication of increased or diminished pressure of air. In ascending or descending elevations, the hand of the aneroid may be seen to move (like the hand of a watch) showing the height above the level of the sea, or the difference of level between places of comparison."*

In the admiral's "Notes on Meteorology," he says, "The aneroid is an excellent *weather glass* if well made. Compensation for heat or cold has lately been introduced by efficient mechanism. In its *improved* condition, when the cost may be about 5*l*., it is fit for measuring heights as far as 5000 feet with approximate accuracy; but even at the price of 3*l*., as a *weather glass* only, it is exceedingly valuable, because it can be carried anywhere; and, if now and then compared with a good barometer, it may be relied on sufficiently. I have had one in constant use for ten years, and it appears to be as good now as at first. For a ship of war (considering concussion by the fire of guns), for boats, or to put in a drawer, or on a table, I believe there is nothing better than it for use as a common weather-glass."

In the third edition of the admiral's "Barometer Manual," a work intended for the use of fishermen and farmers, he writes, "Now that the exclusive patent for making aneroid barometers has expired, it is to be hoped and expected that our opticians will produce trustworthy and even yet more portable instruments, on the same principle mainly, but improved in manufacture as well as in the principle itself. One kind may soon be anticipated exactly compensated for changes of temperature, accurately (not *equally*) graduated on the disc surface, and as superior to the common aneroid as a chronometer is to a cheap watch; but this instrument must be comparatively expensive. Another description (a modification of this admirable French instrument) may be considerably cheaper and *smaller* than the present popular one. It may be a "pocket weather-glass" (so to speak), suitable for fishermen, pilots, or seafaring persons employed in boats or small coasting vessels, without space to suspend or means to provide a mercurial barometer."

Colonel Sir H. James, R.E., in his "Instructions for taking Meteorological Observations," says of the aneroid, "This is a most valuable instrument, it is extremely portable. I have had one in use for upwards of ten years, and find it to be the best form of barometer, as a "weather-glass," that has been made."

It appears therefore that aneroids are now manufactured almost perfectly compensated for temperature. Such an instrument therefore ought to show the same pressure in the external air at a temperature say of 40°, as it would in a room where the temperature at the same time may be 60°; provided there is no difference of elevation. To test it thoroughly would require an examination and a comparison with barometer readings reduced to 32° Far., conducted through a long range of temperature and under artificially reduced pressure. A practical method appears to be to compare the aneroid daily, or more often for a few weeks, with the readings of a mercurial barometer reduced to 32°; and if the error so found be constant, the object of the compensation may be assumed to be attained, particularly if the temperature during the period has varied greatly.

* Allowing 0·0011 of an inch for each foot.

Aneroids are generally suspended with the dial vertical; but if they are placed with the dial horizontal, the indications differ a few hundredths of an inch in the two positions. Hence, if their indications are registered, they should be kept in the same position.

The aneroid will not answer for exact scientific purposes, as it cannot be relied upon for a length of time. Its error of indication changes slowly, and hence the necessity of its being set from time to time with the reading of a good barometer. To allow of this being done, at the back of the outer case is the head of a screw in connection with the spring attached to the vacuum box. By applying a small turnscrew to this screw, the spring on the vacuum box may be tightened or relaxed, and the index made to move correspondingly to the right or left on the dial. By this means, besides being enabled to correct the aneroid at any time, "if the measure of a height rather greater than the aneroid will commonly shew, be required, it may be *re-set* thus—

When at the upper station (*within its range*), and having noted the reading carefully, touch the screw behind so as to bring back the hand a few inches (if the instrument will admit), then read off and start again. *Reverse the operation when descending.* This may add some inches of measure *approximately*."

For measuring heights not exceeding many hundred feet by means of the aneroid, the following simple method will suffice:—

Divide the difference between the aneroid readings at the lower and upper station by ·0011; the quotient will give the approximated height in feet.

Thus, supposing the aneroid to read at the

Lower station	30·385
Upper station	30·025
Difference ..	·360

$$\text{Divided gives } \frac{\cdot 360}{\cdot 0011} = 327 \text{ feet.}$$

ON TIMING POCKET WATCHES.

In making first-class watches, all the parts which constitute a perfect machine may appear to be well executed, yet it commonly happens that the performance is not satisfactory; in such cases, the error chiefly lies in that essential operation known as the Springing and Timing. There can be no doubt that the employment of a pendulum spring and balance, is the best form for a pocket timekeeper, it being necessary that the machine should maintain its accuracy in any accidental position, and such a contrivance dispenses as much as possible with the influence of the earth's attraction; indeed it forms an artificial gravitating power in itself, and when the balance is at rest in a watch, with the pendulum spring at ease, it is at its centre of gravity; by the application of power through the mainspring, the escapement drives the balance from its state of rest, and consequently from its centre of gravity, to which the pendulum spring is constantly endeavouring to restore it: and by a repetition of impulses, the motion of the balance is kept up: therefore it appears, that the balance and pendulum spring embrace the elements of timekeeping, and that the rest of the machine is only necessary for the purpose of keeping these parts in motion, and of registering the result on the dial.

In timing pocket watches, in which from the kind of escapement used, a very long vibration is produced, many difficulties arise; for when the machine is placed a vertical position, and the whole weight of the balance rests on the diameters of the pivots, it appears evident that the power of the pendulum spring is checked by the friction of these necessary supporters. On the other hand, when the watch is in a horizontal position, the weight of the balance is supported on a single point, hence its greater freedom of motion, and tendency to gain. It has however been discovered, that the pendulum spring possesses a peculiar power; for a timer who is thoroughly initiated in the art can make all the hanging positions go faster than the lying positions, in opposition to the friction on the sides of the two balance staff pivots; and further, he can produce what is called an isochronal state of the spring, which is the making any length of vibration produce the same result in a given time; when this is attained it commonly happens that from some undiscovered cause, the performonce in positions will be unequal with a balance of exactly equal weight. If, for instance, with the face up for twenty four hours it proves to be —0·0″; the twelve up for twelve hours may be +5·0″; and the six up for the same time — 5·0″; this is called isochronal in a pocket watch, because the time in the two reverse hanging positions for twelve hours each, averages the same as the twenty-four hours lying, yet there is an error of ten seconds a day. When this result ensues, a method is commonly adopted which certainly entails upon the watch inequality of performance. In order practically to describe the method usually employed I will suppose an open-face watch with a compensation balance, the four quarter screws, when at rest presented to

the quarters 12, 6, 3, and 9, and I will state nearly the required alteration to equalize the error of ten seconds a day fast, with the twelve up, with variable lengths of vibration in the hanging positions, by putting in or drawing out the screws. If the motion of the balance is ¾ of a circle, the twelve o'clock screw must be drawn out ¼ of a turn, and the six put in as much; if one circle of vibration, the twelve must be drawn nearly a turn and the six put in the same quantity; if the vibration is one circle and an eighth, the twelve must be drawn full one circle and a half, and the six put in equal to it; if the motion of the balance is one and a quarter turns, it is useless to attempt to equalize the errors. The reason why so small an alteration is required in the first example (¼ of a turn) is that, in the motion of the balance, the small additional weight at the 12 o'clock is never allowed to descend to its natural state of rest, which if the pendulum spring were removed would be at the six o'clock; therefore it is almost constantly checking the gravitating principle of the pendulum spring, by the earth's attraction being employed in opposition to its power. In the next example (one circle) the heaviest part of the balance descends quite to the six o'clock, at which point the pendulum spring feels no resistance from the earth's attraction, and consequently it exercises its full force; yet during the greater part of the vibration, the additional weight is under the influence of the earth's attraction, therefore an effect on the position can be produced by adding the greater weight at the 12 o'clock.

In the third example (1⅛ turn), the heavy part of the balance is carried the sixteenth of a turn beyond the centre of the earth's attraction; therefore, in returning, it gives force to the pendulum spring; in this case, the additional weight at the twelve o'clock in effect is circulated almost as much at the six as at the twelve, consequently the still greater weight is required to produce the desired result. In the next example (1¼ turn), the additional weight is carried ⅛ of a turn beyond its centre of gravity, and gives a still greater assistance to the pendulum spring in returning the balance than in the former example; with a vibration of this length the unequal weight is so circulated during the motion of the balance, that the equalization of the hanging position becomes almost impossible. It sometimes happens that lever watches vibrate nearly a circle and a half in the hanging position; in such a case, in order to equalize a gaining error of ten seconds a day with the twelve up, the screw at that part of the balance must be lightened, for the motion of the balance is so great that the six o'clock screw becomes effective at the twelve, this is what is called timing in reverse. From these practical observations it appears, that if the twelve o'clock screw requires to be drawn nearly a turn, to equalize the position at one circle vibration, when the motion of the balance is reduced to ¾ of a turn by the thickening of oil and accumulation of dirt, the screw is out more than half a turn too much, consequently, the watch will lose with the twelve up; and this principle of course holds good with regard to all the other illustrations I have given; indeed it must happen if a balance is not exactly equal in weight, that every new length of vibration in the hanging positions—whether produced by the accumulation of dirt or the motion of the body during wear—must cause a new rate; and although an error of ten or even twenty seconds a day may appear, as a principle, I am of opinion it is much better for the future good performance of a watch that such error remain, than that the balance be thrown out of equal weight in order to equalize the positions.

Arthur P. Walsh.

A BRIEF DESCRIPTION OF

THE ASTRONOMICAL CLOCK OF THE CATHEDRAL OF STRASBURG.

By Charles Schwilgue.—Strasburg, 1844.

(*Continued from page 113.*)

Part II.

On the New Clock.

The present astronomical clock, commenced on the 24th June, 1838, was set going for the first time, on Sunday the 2d of October, 1842, on the occasion of the Tenth Scientific Congress of France, which met at Strasburg. It was solemnly inaugurated on the 31st of December, when a nocturnal fête was given to the author.

This work, which has just been completed by the fixing up of a celestial sphere, is entirely of my father's invention; no part of the old clock having been found capable of being made use of, with the exception of some statuettes, of which some serve only as ornaments and others have had movements more natural communicated to them.*

* Persons who wish to see the mechanism, and the parts belonging to the old clock, have only to apply to the housekeeper, at the Frauenhaus, who will at the same time show them a staircase of a very curious construction.

All the old indications, for the most part represented in painting, could only serve for very limited periods, now they are reproduced, without limit of time, by mechanical combinations, the exactitude of which leaves nothing to be desired: besides these astronomical indications, the clock shows many others, which were not known in the time of Dasypodius. Finally, to preserve the traditions of the old clock, the memory of which is so popular in our country, the divers mechanical works have been made in such a manner, notwithstanding the numerous augmentations with which the new one has been enriched, that they have been able to be put in the old chamber.

I. The clock is a restoration, and is surrounded by an iron railing and a wooden balustrade, but these are placed in an inverse order to that of the old clock. The railing, of a simple but elegant form, is disposed so that from the outside one may easily see the clock, whilst the balustrade breast-high serves at once to protect the sphere, and to secure a space reserved for persons who wish to give some time to the attentive examination of the various mechanical contrivances.

II. Below the clock is placed a celestial globe, indicating upon a dial-plate, the sidereal time; that is to say, the diurnal motion of the stars. This globe, made of copper, and supported by four handsome metallic pillars, is rectified for the latitude of Strasburg. All the stars of the first six orders of magnitude, above 5000 in number, are represented in their true relative positions, upon a ground-work in imitation of the celestial concave; these stars, grouped into 110 constellations, easy to distinguish, are designated by Greek and Latin letters, by which they can be recognised. The globe revolves from east to west, in a sidereal day; that is, in the interval between the successive returns of the same star to the meridian, a duration shorter by about 3 min. 56 sec. than that of the mean solar day. In its motion round its axis, the globe carries with it the circles that surround it, namely, the equator, the ecliptic, the sostitial and equinoctial colures, whilst the meridian and horizon circles remain motionless; it thus shows us the moment of the rising and of the setting, as also that of the passage over the meridian of Strasburg, of all the stars visible to the naked eye, which appear above the horizon.

Over and above this motion, remarkable for its accuracy, the circles which move with the globe change their position, so as to be subject to the influence, almost inappreciable, of the precession of the equinoxes; this retrograde change of position is so imperceptible, that it requires about 25.804 years* for these circles to make their complete revolution round the sphere (or globe), in this motion the variable equinox will constantly be found to coincide with the point of the heavens to which it answers; now, as is well-known, noon of the sidereal day is indicated by the passage of the equinoctial point over the meridian.

III. Immediately behind the celestial globe, there is a compartment devoted to the calendar. A metallic band, in the form of a ring, having a breadth of only about 25 centimetres (9·84 in.), by a circumference of over 9 metres (29½), carries upon a gilded ground, all the indications of a perpetual calendar, the months, the day of the month, the dominical letters, the names of the saints, (moveable feast days), as well as the fixed feast days. This ring, which is moveable, advances one division each day, the passage from one day to another being effected instantaneously at midnight.

A statue, representing Apollo, stands on the right of the calendar, showing or pointing out, with an arrow that he holds in his hand, the day of the year and the name of the saint corresponding to that day. Diana, under the form of the goddess of the night, is placed on the other side, and, merely to serve as a companion figure for the god of the day.

The calendar performs its revolution in 365 or in 366 days, according as it is a common or leap year; and, besides, gives rise to an irregularity known under the name of secular bissextiles, that is, it performs of itself the cutting off or suppressing of 3 days in 400 years.

Between the 31st of December, and the 1st of January, the calendar bears the words " Commencement de l'année commune " (begining of the common year), which words continue to rest in their place so long as the years are ordinary ones, that is of 365 days; it is no longer so in the leap years; the word commune (common) disappears, and a new day is intercalated between the 28th of February and the 1st of March.

Independently of these combinations, which in the clock have no limit, as they are reproduced for an indefinite time, the calendar indicates also the moveable feasts, namely, Septuagesima, Good Friday, Easter Sunday, Ascension Day, the Feast of Pentecost, of the Holy Trinity, of Corpus Christi, and two in Ember week, &c. The moveable

* To avoid noting the periods with all their subdivisions, we have confined ourselves in this account to the principal units.

feasts arrange themselves each year, on the 31st of December, at midnight, to the days to which they correspond in the new year; thus fixed, they preserve their position till the termination of the following year.

Besides the moveable feasts, which depend upon Easter Day, and which, as we shall see, are reproduced by the ecclesiastical computation; the calendar moreover shows, by the aid of peculiar mechanism, the first Sunday in Advent, as well as those of the Ember weeks, which are derived from it: further, it indicates the Feast of St. Arbogatte, patron of the diocese, which feast is a moveable one, and always celebrated one Sunday in the last fortnight in the middle of July.

The figures, perfectly characteristic, occupy the four angles of this compartment; these figures, which are due to the pencil of Tobias Stimmer, the painter and sculptor of the old clock, represent Persia, Assyria, Greece, and Rome, or the four monarchies of the ancient world, according to the prophecy of Daniel.

IV. The internal part, comprised in the annular band of the calendar, is solely destined to indications of apparent time; that is, to the different motions of the sun and of the moon, such as we see them in the sky.

We know that the time employed by the sun in returning to the same meridian, or the time that elapses between two successive noons, as shown by a good sun-dial, is not the same for each day of the year; now, from this irregular progress, it comes to pass that a clock correctly regulated will not keep time with the sun; sometimes the clock will be too fast, sometimes it will be too slow, and this disagreement may amount to as much as 16 minutes. The days formed by each apparent revolution of the sun, are named solar days; they are still designated by the name of true days, because they show the true moment of the passage of the sun over the meridian.

The dial-plate of apparent time, azure coloured, is surrounded by a silver circle, upon which are seen twice the hours, from 1 to 12, with their subdivisions into minutes. This plate serves for the representation:—

1st, Of the Rising and Setting of the Sun.

2d, Of True Time.

3d, Of the True Diurnal Motion of the Moon round the Earth, or its True Right Ascension, and its passage over the Meridian.

4th, Of the Phases of the Moon.

5th, Lastly, of the Eclipses of the Sun and Moon.

The hours of the rising and the setting of the sun are shown by means of a moveable horizon, which divides into two parts the circles (passed over) or traversed by the sun; thence may be deduced the length of each day and each night. Thus, at the equinoxes the sun is seen to rise about six in the morning, and to set about six in the evening; and, at the summer solstice, he rises about four in the morning and does not sink below the horizon till about eight in the evening, whilst at the winter solstice, he is not visible till about eight in the morning, and sets as early as four in the afternoon. In these indications, which are expressed in true apparent time for the meridian of Strasburg, regard has been had to the law of refraction, in virtue of which the luminous rays which proceed from the sun, undergo, in entering the earth's atmosphere, a refraction which causes them to appear farther above the horizon than they really are.

Two needles or pointers of the same colour as the dial upon which they are projected, are terminated, one by a gilt disc with rays representing the sun, and the other by a small globe of a silver colour on one side and black on the other representing the moon.

The diameters of these two heavenly bodies are exactly proportional to the mean apparent size of the sun and moon, a circumstance that renders them suitable for indicating eclipses.

For this end, the earth, represented by the northern hemisphere, occupies the centre of the dial; this hemisphere, which is adjusted so that the meridian of Strasburg is represented as vertical, represents with the greatest accuracy, all the countries situated between the equator and the north pole; it may therefore serve to point out the time of the passage of the sun and of the moon over the meridians of those different countries; it is thus that we may see that the sun passes the meridian of Paris about 22 minutes later, and that of Vienna about 34 minutes sooner than that of Strasburg.

During the revolutions which the sun and the moon perform round the earth, in unequal intervals, it happens that these bodies are, one with regard to the other, in positions peculiar and very different.

If the moon is on the same side as the sun, in respect to our planet, and if at the same time she is in her nodes or nearly so, that is, near the points where the orbit of the moon cuts the plane of the ecliptic, she will come between the sun and the earth; now, as our satellite is an opaque body, it will hide the sun from a portion of our globe; thus, treating the inhabitants of those countries to an eclipse of the sun. During this phenomenon, the darkened portion of the moon will be turned to the spec-

tator; and the sun will be hidden so much the more as the eclipse may happen to be partial or total.

On the contrary, if the moon is on the side of the earth opposite to the sun, and if at the same time she is in or near her nodes, the earth being then between the two bodies will hinder the light of the sun from arriving at our satellite, there will then be an eclipse of the moon, a phenomenon which, in the clock, is represented by the occultation of the globe of the moon, which is concealed by a disc representing a section of the cone of the earth's shadow; this obscuration is greater or less, according as the eclipse is total or partial; it is moreover northern or southern, according to the position of these heavenly bodies. This part of the clock indicates, with all the precision mechanically possible, those celestial phenomena which were subjects of terror to the people, and which at present, may be calculated and predicted; the clock shows not only all the visible eclipses, but also those which are invisible at Strasburg; moreover it shows, by the inspection of the hemisphere, which are the countries in which these phenomena are apparent.

As the eclipses of the sun cannot occur except at the times of the conjunctions, that is, at the period of the new moon, and the eclipses of the moon only take place at the oppositions, or at the time of the full moon, it is easy to perceive that our satellite ought, besides the motion which it has round the earth, to show itself sometimes enlightened, sometimes obscured, in order to present to us the phases or different appearances, such as they appear to our eyes each lunar month.

The orbit traversed by the satellite and the earth being moreover inclined to the ecliptic, it is further easy to perceive that in its path round the earth the moon should at one time approach, at another time recede from the path apparently described by the sun (that is the ecliptic), and this according to its northern or southern latitude. Each of these latitudes will be indicated in the clock by the position of the moon, according as she may be situated beyond or on this side of the sun, and according as she may pass before this body at the time of her nodes.

V. From the arrangement which serves for the explanation of the apparent revolutions of the sun and moon, the attention naturally turns itself to the two compartments which adjoin it; that to the right of the spectator serves, as is announced by the words "*comput ecclesiastique*" (ecclesiastical computation), for the calculation of the different elements of time necessary for regulating the calendar, and principally the feasts of the church. It is the first time that there has been formed, by the aid of mechanical combination, a perpetual calendar, and an ecclesiastical computation; these are not the only portions of the clock that were invented by my father; he is also the author of all the parts of which we have already spoken, as also of those which yet remain to be described.

(*To be continued.*)

METEOROLOGICAL OBSERVATIONS,

Taken at 9 A.M., APRIL, 1861.

Gray's Inn Road.

REMARKS.

The letters denoting the weather signify:—b, blue sky; c, clouds (detached); f, fog; m, mist; o, overcast or dull; r, rain; r r, heavy rain.

Between 1st and 6th, the wind veered completely round the compass, from E through S, W, and N, to E. The lowest barometer reading observed during the month was with the S wind on the 2nd at 9 a.m. At

11 p.m. of 9th and at 8, 9, and 10 a.m. of 10th, the reduced barometer reading was precisely 30·583, and this was the highest noted, the wind being E, force 3. Thus the extreme range of the mercury in the barometer has been only 0·87 inch, apparently. The mean pressure of the air, deduced from the 9 a.m. observations, has been 30·176. This high and steady condition of the atmospheric pressure has been accompanied with fine weather and moderate winds from the NW, N, NE and E.

Altogether April has been a splendid month (to the great grief of the weather prophets), though the warm sunshine has been harshly tempered with north-easterly winds; and the cloudless nights, favouring radiation from the earth, have occasionally been very cold. For about three weeks scarcely any rain fell over any part of the British Isles.

The increased difference between the dry and wet thermometers, compared with that of previous months shews that the London air was free from excess of moisture. The weather has been highly favourable for agricultural operations. R. S.

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

(*Continued from page* 69.)

1845, April 17.—No. 10,625.

PIGGOT, William Peter.—1. Dials and graduated plates manufactured by the electrotype process. A plate is prepared of suitable size with the necessary graduations and figures engraved thereon. A mould is then obtained in a composition of wax, and from this mould any number of similar plates in copper or other suitable metal may be obtained by the electrotype process. The mould may also be originally taken in copper from the plate by this process, and will be more durable.

2. Relates to the manufacture of compass boxes.

[Printed, 3*d.* See Repertory of Arts, vol. 7 (*enlarged series*), p, 338 ; and Engineers' and Architects' Journal, vol, 8, p, 321.]

Errata in our Last.

Page 111, line 22 from top, for "were" read "was."
Page 112, line 25 from top, read "grandson of the colleague of Dasypodius."
Page 112, line 15 from bottom, for "Apollon," read "Apollo."
Page 113, line 19 from bottom, for "quarter," read "greater."

EQUATION OF TIME TABLE

For June 1861.

Day of the Week.	Day of Mnth	At Apparent Noon — Equation of Time to be *added* to Apparent Time.	Difference for One Hour.	At Mean Noon. — Equation of Time to be *subtracted* from Mean Time.
		m. s.	s.	m s.
Sat. ..	1	2 29·65	0·384	2 29·64
Sun. ..	2	2 20·43	0·401	2 20·41
Mon ..	3	2 10·80	0·417	2 10·79
Tues ..	4	2 0·79	0·432	2 0·78
Wed ..	5	1 50·43	0·446	1 50·42
Thurs..	6	1 39·72	0·459	1 39·71
Fri. ..	7	1 28·69	0·472	1 28·68
Sat. ..	8	1 17·37	0·483	1 17·35
Sun. ..	9	1 5·79	0·493	1 5·78
Mon...	10	0 53·96	0·502	0 53·96
Tues ..	11	0 41·90	0·510	0 41·90
Wed..	12	0 29·65	0·517	0 29·65
Thurs..	13	0 17·25	0·523	0 17·26
Fri. ..	14	0 4·71	0·528	0 4·71
Sat. ..	15	0 7·95	0·532	0 7·95
Sun. ..	16	0 20·71	0·535	0 20·71
Mon ..	17	0 33·55	0·537	0 33·54
Tues ..	18	0 46·43	0·538	0 46·42
Wed ..	19	0 59·33	0·538	0 59·32
Thurs .	20	1 12·24	0·538	1 12·23
Frid...	21	1 25·14	0·537	1 25·13
Sat....	22	1 38·01	0·534	1 38·00
Sun...	23	1 50·82	0·531	1 50·81
Mon...	24	2 3·57	0·527	2 3·55
Tues ..	25	2 16·22	0·523	2 16·20
Wed ..	26	2 28·76	0·517	2 28·74
Thurs .	27	2 41·18	0·511	2 41·16
Frid ..	28	2 53·45	0·505	2 53·43
Sat ...	29	3 5·55	0·497	3 5·53
Sun...	30	3 17·47	0·488	3 17·44

TO CORRESPONDENTS, &c.

All Communications for this Journal should be addressed to the Editor, *at the Office*, 35, Northampton Square, Clerkenwell.

N.B—All Advertisements to be inserted in the Journal must be forwarded to George E. Mylne, Honorary Secretary, at the Office 35, Northampton Square, E.C. before the 23d of the Month.

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BRITISH HOROLOGICAL INSTITUTE.

ANNUAL MEETING.

On Friday the 21st ult. at the Institute-House, Northampton Square, the Annual Meeting of Members was held, for the following purposes:—To receive the Report for the past half-year, with an Audited Financial Statement; and to elect the following officers for the year ensuing:—a President, three Vice-Presidents, one Trustee, in the room of Mr. ADAMS (resigned), an Honorary Secretary, and a Council of Twenty-eight members; for the Election of Honorary Members of the Institute; and for Alterations of the Laws.

The President, VALENTINE KNIGHT, Esq., J.P., said that he occupied the chair for the first time upon such an occasion. His absence, however, had not been occasioned by any want of interest in the affairs of the Institute, the prosperity of which he had at heart as much as any member. Whenever they thought that he could benefit it they might depend upon his attendance and his services.

Scrutineers.—Messrs. Baker, Wilde, and Bishop, were elected.

The HONORARY SECRETARY then read the following—

REPORT OF THE COUNCIL, FOR THE HALF-YEAR ENDING 15TH JUNE, 1861.

"GENTLEMEN,—The Council have much pleasure in placing before you the Report of the proceedings and progress of the Institute for the past Half-year, together with an Audited Financial Statement.

"The number of Annual and Half-yearly Members at present amounts to 307; besides 11 Founders; 19 Life Members; 16 Junior Members; and 114 Donors. 40 Annual and Half-yearly, and 4 Junior Members have joined since the last meeting in December, 1860.

"*The Horological Journal*, during the past half-year, has been enriched with valuable Articles on Horology and other scientific subjects, and translations from eminent foreign Authors; others of great practical value are now in the course of publication. To their much esteemed Contributors, and to the Journal Committee, the Council offer their best thanks. It is also gratifying, that in addition to the gratuitous circulation of the Journal amongst the Members, it has now become thoroughly remunerative.

"*The Museum.*—A large number of additional objects having been presented to, and deposited in the Museum; the whole have been admirably re-arranged, and a new descriptive catalogue has been deposited in the Museum for reference, which shows that although our collection is but small, yet it contains some most interesting and instructive examples.

"With reference to the *Standard Gauge of Measurement*, some valuable contributions have been received, both from home and foreign correspondents, and more have been promised. The subject has also been alluded to in the public press, in connexion with the Institute, and there can be no doubt, that it will ultimately tend to advantage, both to the mechanical public and our own objects. It is contemplated to publish reports from time to time, as occasions may arise.

"The thanks of the Council have been given to the Lords of the Admiralty, for their kind presentation of a marine chronometer for the Museum; and also to the many other donors, as enumerated in the Journal.

"*Lectures and Classes.*—During the past half-year, Three Lectures have been delivered by Dr. DRESSER, F.L.S., and are in course of publication in the Journal;—these lectures are important to those engaged in horological productions, as eliminating those general principles of design which equally with all art embellishment should guide this manufacture in its appeal to the public taste. The Council announce, with the greatest pleasure, the liberal offers of W. HISLOP, Esq., F.R.A.S., and E. D. JOHNSON, Esq., F.R.A.S., to give gratuitously in the coming session, the former a course of Ten Lectures on Mechanics, and the latter, Two on the Pendulum; and the Council would urge upon its many talented members an imitation of their valuable efforts.

"*The Discussion* took place on the 9th of Jan., on the subject of the Paper read by JAS. F. COLE, Esq., V.P. These discussions the Council regret have not been maintained as might have been expected, but it is hoped that the Members themselves will remedy this by proposing additional subjects of practical interest.

"*Institute Classes.*—The Council trust that the Members will appreciate the value of the Educational Classes, as affording much that is valuable to their sons, the Junior Members, who should certainly not be without the knowledge they impart, and upon which is based all success in perfecting the students as horologists. The Council have to announce the retirement of W. S. HOARE, Esq., and they trust that the pupils will derive as much benefit under the new Masters that have been engaged in his room, as they obtained under his valuable tuition.

"*The Annual Dinner* of the Institute, held on the 19th of February, at the Freemason's Tavern, was this year favoured with the presence of our esteemed President; and the zeal and talent displayed by the speakers in favour of the uses of the Institute, in promoting the Science and Practice of Horology, showed that the determination to support the Institute had suffered no diminution during the past year."

The CHAIRMAN remarked that the Report appeared satisfactory, and he hoped that it would long continue so. It would be a disgrace to the members of the watch trade if it were otherwise.

The Report was then received and adopted.

FINANCIAL STATEMENT.

The Financial Statement, from December 15th 1860 to June 15th 1861, shewed as the total of Receipts £205 6s. 8d., and of Expenditure £173 15s., leaving a balance in the Treasurer's hands of £31 11s. 8d.

Mr. STRACHAN made some observations on the Balance Sheet which was submitted to the meeting; and a few remarks were also made by Messrs. E. J. THOMPSON, JACKSON, and the Honorary Secretary.

Mr. TREWINNARD, as a member of the Finance Committee could bear testimony that at the present time the Institute had a much larger amount of good debts than it ever had before; nearly enough to bring the balance up to the largest sum it had ever reached; whilst at the same time the Institute owed less than ever it had done.

Mr. WALTERS, as one of the member's auditors for the past year, expressed his entire satisfaction with the present financial aspect of the Institute. There was a time in its history, when the Journal did not pay; but now the receipts covered the whole of the expenditure on its account.

VOTES OF THANKS TO RETIRING OFFICERS.

The Chairman submitted a resolution to the above effect, which was agreed to *nem. con.*

VOTE OF THANKS TO THE PRESIDENT.

Mr. E. D. JOHNSON, moved a special vote of thanks to Mr. Valentine Knight, as a mark of their approbation of his services, and their appreciation of his kindness. It was in the power of very few men, as it was in that of their worthy Chairman, to do a young Institute so much service, and how willing that gentleman was to aid it the members had had abundant proof.

Mr. JACKSON had much pleasure in seconding the resolution, which was put and carried with acclamation.

The CHAIRMAN was afraid that his kind friend, Mr. Johnson, had been rather hyperbolical in his praises of Mr. Knight, whose attendance had been very bad, and whose ability to serve the Institute was very small. All he could boast of was, having sincere desire for its prosperity. He believed, as he had stated on former occasions, that there was no man who wore a watch who ought not to give something to its funds. Many a merchant in the city of London would contribute his five or ten guineas if he only reflected upon the value of the watch he wore, and the importance to him, as a 'commercial man,' of having made for him through the scientific skill of the watchmaker, such a valuable instrument for keeping accurate time. It would indeed be a disgrace, not only to the trade, but to the public at large, if the British Horological Institute did not succeed. He trusted the time was coming when they would have a very different President from himself, Mr. Knight, (*Cries of* "No, no.") They ought to get some peer of the realm to take that position, because he believed that the Institute was one of the most valuable in the metropolis. He trusted that the gentlemen who had been kind enough to support it up to the present time, would endeavour to enlist in its favour as many friends as possible, whether watchmakers, or persons unconnected with the trade. There was one part of Mr. Johnson's speech, and one only, which he could take to himself, and that was that he felt deeply interested in the welfare of the Institute.

THE RETIRING TRUSTEE.

Mr. HISLOP moved a special vote of thanks to the above-named gentleman, who had served as Trustee from the commencement of the Institute. He had now left his business and the neighbourhood of Clerkenwell, and consequently, could not perform the duties of a Trustee to the Institute; their thanks were, however, due to him as one of their best supporters in its early days.

Mr. GORDON seconded the resolution, which was carried unanimously.

The CHAIRMAN liked the favours of the members to be divided as far as possible; but having the responsibility, which he should be very happy to continue, he should be glad to resign his Trusteeship to some other gentleman. ("No, no.")

VOTE OF THANKS TO MR. MYLNE, THE RETIRING HONORARY SECRETARY.

Mr. E. D. JOHNSON proposed that the special thanks of the meeting should be given to a gentleman who had worked harder than any one else, gratuitously, in behalf of the Institute, namely, their retiring Honorary Secretary, Mr. GEORGE E. MYLNE. They could comprehend his love for art, and how long years of attachment had induced him to devote a great deal of time to it, for which they ought to be deeply grateful to him. He (Mr. J.) could scarcely imagine, although he hoped great things from the gentleman who was about to become Honorary Secretary, that he would be enabled to equal his predecessor in the amount of labour he would bestow upon the management of the Institute.

Mr. WATSON seconded the resolution.

The CHAIRMAN said, that if he could add anything to strengthen Mr. Johnson's remarks, in relation to the labours of Mr. Mylne, he should have been very glad to have done so. He had never met with a gentleman who had devoted so much time and attention to the affairs of a society as their late Hon. Secretary had done. His great attention to its interests, and his accuracy in accounts entitled him to the warmest thanks of the members.

The resolution was put and carried unanimously, amidst applause.

Mr. MYLNE most sincerely thanked the Chairman, Mr. Johnson, and the meeting, for the kind compliment they had paid him. He felt that the time he had devoted to the management of the Institute, had been greatly to his own advantage. Any man who took an active part in the affairs of such associations, would be enabled to learn a great deal about his own trade, if he was willing to do so. His (Mr. M.'s) services had further

On the Evening of Monday, June 24th, 1861, at the same place, Mr. W. B. Crisp, in the Chair, the following Report from the Scrutineers was read by Mr. Mylne:

" 3d " 38 " 9.—Carried.

The Report having been received, and ordered to be entered on the minutes,

A vote of thanks to Mr. Crisp for his services in the Chair, closed the proceedings.

ARTISTIC BOTANY: ITS APPLICATION TO THE LAWS OF ORNAMENTATION.

By Dr. C. Dresser, F.L.S., F.E.B.S.

Lecturer at the South Kensington Museum, the Crystal Palace, the Polytechnic Institution, and the Metropolitan Hospitals.

Second Lecture.

Delivered for the British Horological Institute, *at the Parochial School Rooms, Amwell Street, Clerkenwell, on the Evening of February* 15*th*, 1861.

Mr. E. D. Johnson, V. P., in the Chair.

Mr. Chairman, Ladies, and Gentlemen,—I have an extremely difficult task to accomplish this evening, for the present course of lectures being limited to three, I shall be compelled to pass over such a vast amount of ground this evening that I fear I shall rather bewilder you than convey any definite amount of instruction to your minds. I feel honoured in being called upon to address a society, the Council of which has requested me rather to instruct than amuse its members. Lecturers are too often desired to do the latter rather than the former, that it is a relief to be able to dispense with mere amusement, and to confine one's-self to those important principles of science, which, however dry and devoid of interest to the superficial learner, are nevertheless of the greatest value to the serious student. This must be my apology for the manner in which I am compelled to treat my subject this evening; because in applying the laws of plant growth to the art of decoration, there are such a vast number of points necessary to be entered into, and which if omitted would leave the chain of argument incomplete, and would throw some great principle out of sight, and I fear lead you into error than truth. I shall, therefore, be obliged to throw out some points with great temerity, leaving you afterwards to work them out fully for yourselves, which I am persuaded you will find great pleasure in doing.

At the close of my last lecture I called your attention for a few minutes to certain geometrical forms, and suggested the propriety of your studying them in their varied relations. I had hoped this week to have been able to produce a diagram which should illustrate a number of those combinations which this one diamond form is susceptible of. I have only had time, however to produce two or three rough sketches. Here we have a star formed of diamonds radiating from the centre. If you leave a diamond between them you would have in the centre a star completely surrounded by diamonds. Some of the stars may be hexagonal, or six-sided; so that taking as the basis the centre of the star, we should have a row of hexagons surrounding it. You will notice that most of those diamonds can be combined in this manner so as to produce a form of this description. You perceive that this form is in reality three diamonds placed together in the manner there indicated. It would have afforded me much pleasure, could I have shewn you the number of variations of which this form is susceptible. There is one which is particularly interesting, for this reason, that it will repeat all over the ground. In this form you see the positions are placed together so as to have the angles radiating from the centre; but in this other arrangement we get a figure which will repeat all, even the ground, and leave no space between it.

Let me direct your attention to one distinguishing feature in ornamentation. Hitherto we have been dealing with flat surfaces. It must be specially borne in mind that when I speak of these geometrical figures, I do so not in relation to surface. Do not suppose that they are solid bodies. It is only in that light that the remarks I have previously made will apply. Here is a model; it is imperfect; but it will enable me to illustrate what I mean. If I take a superficial form—that is, if I deal with surfaces only—with such bodies as those, and take away the terms "equilateral triangle" and "triangle" sides which are of the same length, and divide that into triangles, you will notice that I divide it into four equilateral triangles; that is, I divide the triangle into four. But not so with the solid. Here I cut off one corner, and it becomes an equilateral triangle; a solid triangle; a four-sided figure. I cut off another corner, and then another, and I have now a triangle left; but bear particularly in mind the difference between dealing with superficial and solid forms. I recommend you, even if only as an exercise for the mind, to follow this out. This is all cut out of one piece of cardboard, which you will readily see the form of. The learner may derive a great deal of practical benefit from the study of this matter. It will enable you to see the relationship of forms to one another. Mark-

ing the forms of the solid crystals with which we are familiar, will prove of the utmost interest in connection with the study of the ornamental arts.

In dealing with solid forms, such as jewellery, for instance, we are dealing with something totally different to what we have in a superficial form, such as the back of a watch. I may just allude to one amusing illustration of these principles. I have here what is called a Chinese puzzle; a string of things familiar to every school-boy; comprising a certain number of little pieces of wood placed together in a box. These will make an almost infinite number of forms. It certainly is a good geometrical exercise. This is an annual which appeared last Christmas, and was very popular for a time. It has a great number of forms which can be made from these little seven portions of wood. Along with it a key was published, shewing you how they were made, but I am happy to say that it is incorrect in several instances so that you will have practically to find out for yourselves how they are done. This amusement for children, however is a really good exercise for the mind. It is a step in the right direction. Certainly it is not as perfect or as useful as the more regular geometrical forms of the present time. I have been wandering from the prescribed subject of my evening's lecture; but I thought it would be useful to make a few further remarks upon the geometrical question which I briefly introduced upon the last occasion.

I have now, in the first place, to call your attention to two views of plants. We are familiar with distinct views of vegetable structures. If we take a large tree, for instance, we only have its side view. I had a splendid illustration of that fact. I wanted, for a work I was publishing, a top view of a tree, and I could not find anybody who could draw it. Every person I asked about it replied that they had not been up in a balloon, and therefore did not know how a tree looked from above. I at last succeeded in persuading a friend well versed in such matters to try and draw one, which when finished some guessed to be a peg-top; nobody knew what it was meant for. It was necessary to put a shadow to it to make it out at all. When somebody suggested the putting in a cow and a sheep or two. This was an improvement, because the shadow of the cow could be made to look something like a cow. Those were the means we were compelled to adopt to render the thing intelligible at all. Then it was thought quite desirable to put a name underneath, lest persons should not find out what it was. This incident shews that we are not familiar with the top view of certain plants, but only with their side views.

There are other instances in which we become familiar with the top view of plants only. Take for example, the daisy, the dandelion, the plantain, and plants of that kind. Then there are the little plants which grow down amidst the grasses. All of those we know perfectly well, and can say without hesitation, whenever we see them. Do you know their side views? It is quite possible that I am addressing an assembly not one of whom has ever seen the side view of a daisy or a dandelion. If you were to see a drawing of a dandelion's side view, I mean the plant, not particularly the flower, because we are in the habit of pulling it, and then we look at it sideways—we should not recognize it. This fact proves that we are at once familiar with two distinct views of plants, their side view and their top view. Plants manifestly resolve themselves into those two classes as presented to the eye. In like manner they present us with two distinct classes of ornament, viewing them only in an ornamental point of view. That is, supposing we have got an ornamental pair of spectacles,—in looking through them, we view plants in this way. Every plant with a top view with which we are familiar, is a radiating ornament; that is, it consists of a number of parts radiating from a common centre; whereas every plant with a vertical or side view, with which we are familiar, has, at most, not more than its two halves alike. Here we have a top view of a portion of a plant which is of considerable interest, although it seems insignificant, for it is this which imparts the sweet aroma to the hay. It is called the "woodruff;" it is a sort of goose-grass, and is nearly related to our commons.

This is a radiating ornament; which we have to look down upon from above. It consists of a number of parts radiating from a common stem. Here is a top view of a portion of the sweet scabias, known by the name of "the ladies' pin cushion," a plant which has little dark velvet flowers, having a stem from which they radiate in different directions. That will always be the case whether we view the most extended or the most contracted part; if we look down upon them from above, we shall have a radiating ornament. The radiating principle is very beautifully manifested in what is called "the fairies' ring," which we sometimes call mushroom, and the toad plants. We sometimes find mushrooms spring up in the midst of grass, and by and by they die down. Many of you, perhaps, are familiar with

what is termed "mushroom spawn;" a sort of filamentous matter, extremely like cotton, the threads of which grow underneath the earth in every direction. The growth always takes place in the centre, from which they radiate outwards. We can never see this illustrated better than in this lowest race of plants. The spawn of the mushroom, as soon as it is dead, extends in various directions underneath the surface of the soil. We have one mushroom appearing here, another there, another there, and so on, until we have a circle of them, which some call "the fairies' ring." That will die, and everyone will become a little centre, sending out a kind of radiating spawn, which soon becomes plants; by and by they will die down, and the whole thing will disappear with unfavourable circumstances. When these plants die they become very rich earth, and the grass being nourished by their remains will become more luxuriant than other grasses. These plants are called "fairy rings" because they are popularly said to be produced by fairies. That is the great use of this plant in the economy of nature. When we take a large and extended view of nature, which we may do, we shall find that the work which these plants of such rapid growth that they now appear and are gone, is to prepare the earth for the more highly organized plants. This will give us an illustration of the tendency of all plants which radiate from a common centre. If you think upon the subject you will see that it is the very principle of growth, from the fact that the plants radiate—that the parts puff out—from a central star so that they must grow in a radiating manner. Viewing plants, then, in an ornamental light, let us notice particulary that we have in all cases a radiating ornament. When the plant appears as a floral decoration in the great hall of nature, in that case we have at most only the halves alike.

An opinion is entertained that the ornamental principles of the vegetable kingdom resolve themselves into three classes. We have what are termed ornament by powderings. What I mean by that is little patterns complete in themselves, and which have no connection with any other pattern. If we take a lawn, we see a little bright-eyed daisy getting up here and there. We recognize a little white flower, and see a string of green back ground; but we do not notice that one daisy is connected with another. This view also applies to the primrose which is a powdering ornament. There is a little plant known as "the lady's mantle," not common with us, but plentiful in Yorkshire, which may be regarded as a good illustration of what we term the powdering style of ornaments; they are complete in themselves.

(*To be continued.*)

ON TIMING POCKET WATCHES.

To the Editor of the HOROLOGICAL JOURNAL.

SIR,—Mr. Walsh says, in your last number, that when he has obtained a balance-spring, isochronal in respect to its arcs of vibration, "from some undiscovered cause the performance in positions will be unequal with a balance of exactly equal weight." I presume he means with a balance in a state of equilibrium. This undiscovered cause is undoubtedly the effect of gravity on all the parts in action. In engineering work the bearings are tight, but in watchwork the holes must be sufficiently large to allow side shake, and the end pieces sufficiently distant to allow end shake. The side shake is of course as small as is necessary to obtain the requisite freedom, but yet is sufficient to cause a greater or less depth of engagement in the escapement, according to the position in which the watch is placed. In some escapements placed horizontally, the impulse tends to keep the scape wheel and staff at a distance from each other, but the weight of the balance in a vertical position is sufficient to overcome this thrust and make a deeper engagement. Different positions will give different depths. This will have an effect upon the time. Again the balance-spring whether flat or helical will take a different form in whatever position it is placed, in consequence of the weight of the molecules of which it is constituted. This is so minute as to be totally imperceptible to the senses, but we know that if steel has weight it must follow as a necessary consequence; and when we also know that the change of form in a larger degree alters the time, and that perhaps four hundred and thirty-two thousand vibrations of this spring occur in a day, we must conclude that this likewise, although in a minor degree, has an effect upon the time. In the detached escapement we have another error, viz., the weight of the detent. If we take the extreme cases, in one position the inertia of the balance has to overcome the elasticity of the detent-spring plus the weight of the detent, and in the other minus its weight, and in all positions except two, when the detent is placed vertically, a variable resistence is met with. These several causes and their combinations have the effect of making the watch vary in its different vertical positions.

Mr. Walsh shows, that by altering the screws the correction will only be strictly effective for a certain arc of vibration, and that as the arcs continually diminish through the thickening of the oil and the accumulation of dirt, the adjustment gradually becomes less correct. From this he concludes that it would be better to leave the balance in a state of equlibrium, if even the error should amount to twenty seconds per diem, so that it should vary in positions for all arcs of vibration. This is almost equivalent to saying that it is better to be always wrong than sometimes right.

The fact is, that a watch is an entire system of errors from begining to end. Of course we endeavour to counteract these errors when we can. We make a fusee to compensate the inequalities of force in the mainspring, but it is not perfectly successful, for each fusee ought to be cut to each mainspring, and even then what would be a perfect adjustment now, would be imperfect in a few months, Again, we endeavour to overcome the effect of the variable elasticity of the balance-spring, in consequence of thermal changes, by a compound balance; but we all know that only at two points in the thermometric scale is a perfect adjustment obtained, and at all others, higher, lower, or intermediate, the compensation is incorrect.

It certainly appears to me that the partial correction of an error is better than none at all. I am sir,—Your obedient servant,

74, Cornhill. R. Webster.

Mr. Walsh must pardon me for saying, that I cannot understand how "in the vertical position the whole weight of the balance rests on the *diameters* of the pivots," or that the balance and spring possess "an artificial gravitating power, and when the balance is at rest with the pendulum spring at ease, it is at its centre of gravity."

HOROLOGY.

From the "Mechanic's Magazine."

Perhaps — nay, certainly — there is no country on the surface of the earth where the value of time is more generally or thoroughly appreciated than in Great Britain. The introduction of the railway system especially has tended to the inculcation of lessons of punctuality; while the multifarious transactions of business are so completely interwoven and dependent on each other that the non-observance of one *time* arrangement dislocates a host of others, and occasions incalculable inconvenience and loss. If, then, time is admittedly of so much consequence to the industrial community—and we use the word industrial in its most comprehensive sense—if time is of so much consequence, how necessary that the time-measuring machines in use amongst us should be of the most perfect and inexpensive kind?

Regarded from this point of view, horology assumes so consequential a place among the other useful arts that it is difficult to estimate it too highly. It has not, however, as yet, obtained the consideration among the mechanical workers of the kingdom to which it is fairly and incontestably entitled. In the field of engineering and mechanics the greatest distinction has been attained by Englishmen, and their works exist in every civilized clime as monuments of their skill and ingenuity. Somehow, nevertheless, the mechanical art of horology *has* been, to a lamentable extent, neglected by our fellow-countrymen; and in few instances can we point to any triumph therein achieved by them. Doubtless there are reasons for this. One of these is a narrow-minded and jealous care which has hitherto been exercised by horologists in protecting their craft from the intrusion of what are deemed strangers. The "art and mystery" of clock and watch making in Great Britain has not had the full advantage of home competition. It has been hedged around by the petty restrictions of trade forms and customs, and nursed almost to death by the observance of "trade secrets." It is not long since the rules of the trade forbade the binding of an apprentice to an horologist without binding him at the same time to divulge none of the mysteries which would thereafter be revealed to him. We are quite aware that this vestige of a dark age is dying out, and that the Horological Institution of London is doing its utmost to give it its *quietus*, but its effects unfortunately are painfully apparent in the stagnancy of the arts of clock and watch making at home, and their healthy and vigorous activity abroad. Had a different and more enlightened course been pursued by the clock and watch manufacturers of this country twenty or thirty years ago, how much more flourishing and how much more honourably distinguished might they not have been now? Instead of bemoaning the intrusion of foreign watches and clocks, which threaten to overrun and monopolise the markets of the nation and the world, they would have been able to contend successfully, both as regards quality and price, against them, and to hold up their heads in triumph and in laudable pride, as do our engineers, general mechanists, and a host of other scientific workers of this industrial time.

It may be said that it is of little use to enumerate the causes of the decline of horology in this kingdom; and so it might be if the case were past hope, or past redemption. This we do not believe; and our main purpose is not to point the finger of contumely at those whose persistence in the one-eyed wisdom of a past generation has led to the evil consequences so much to be deplored, but to direct attention to the means by which the languishing patient may be restored to health and strength. In order to accomplish this result, the horologists of England must become earnest and energetic. They must endeavour to impart new energy into their own acts; follow the example set by other trades; and invite the co-operation of those who are above prejudice, and who do not fear honest competition. They must shuffle off the mantle of tradition by which their own movements, as well as those of their clocks and watches, are hampered, and advancing fearlessly and resolutely in the march of manufacturing improvement, they may at length hope to stem the torrent of foreign invasion, and let the enemy see that at last they know "what's a clock,"

The mechanism of a time-keeper, whether it be that of the turret clock, or of the "flat lady's watch," as some advertisements have it, is, as we have shown on a former occasion, extremely simple in its character. There is, in fact, nothing really difficult in its manufacture; and a walk through some of the engine and machine factories of London, or Manchester, or Leeds, would convince the most sceptial that clock and watch making might easily be added to the work therein performed, without any material addition to the mechanical staff already engaged thereon.

If there be a point upon which a doubt may hinge of the success of the experiment of enlisting largely the youthful mechanical skill of the kingdom into the army of watch and clock makers, it is as to the question of design and ornamentation. The *useful* branch of the art there is complete certainty about. Perfect time-keepers might, with little trouble, be made by thousands in the mechanical workshops of England; and that at once would constitute a vast stride towards the revival of horology, and the discontinuance of the importation of foreign specimens of the art.

In the manufacture of clocks and watches there are numerous branches which are entirely of a repetitional nature, and as in many other departments of art manufacture, where this is so, machines are contrived for producing the separate components. So might it easily be in the construction of the various part of clocks and watches. Birmingham would furnish us with innumerable illustrative instances. We propose, then, that horology should be made a national pursuit instead of a local and exclusive one. The demand for correct time-keeping machines is increasing, and must increase, among us; and whilst Clerkenwell and Coventry have proved themselves unequal to the task of meeting that demand, and have caused the country to be deluged with mis-leading articles from France, from Switzerland, and the United States of America, we urge, with all the earnestness possible, the extending of the art of horology far beyond the boundaries of its two noted English seats. The Horological Institution of London is "a great fact" in favour of our arguments, for it is reflecting mental day-light into the dark places of Clerkenwell, and is, in fact, a complete training college for young horologists; and we, therefore, wish it success.

[The above article on "Horology," forwarded per favour of the Editor of the "Mechanic's Magazine," is re-published here to afford the readers of the "Horological Journal," and the Trade at large, an opportunity of judging in what light English Clock and Watch Manufacturing, as a commercial and national enterprize, is regarded by the Author, as compared with the Horological productions of other countries. The general tenor of this article we conceive to invite a reply, and merits consideration.—ED. H. J.]

A BRIEF DESCRIPTION OF THE ASTRONOMICAL CLOCK OF THE CATHEDRAL OF STRASBURG.

BY CHARLES SCHWILGUE.—STRASBURG, 1844.

(*Continued from page* 127.)

The ecclesiastical computation serves to regulate—

1st, The year of our Lord—A.D.
2d, The Solar Cycle.
3d, The Golden Number, or Lunar Cycle.
4th, The Romon Indiction.
5th, The Dominical Letter.
6th, The Epacts.
7th, The Feast of Easter.

I. The year of our Lord or the date of the year, composed of four places of numerals, occupies the upper part of the computation; each of these numerals is carried by a separate circle, upon which the nine first numbers, together with zero are engraved. The circle of the units, which shifts by one figure each year, thus takes 10 years to make one revolution.

The circle carrying the tens, as it moves

every 10 years to the extent of one figure only, thus requires 100 years to accomplish one entire revolution. By analogous combinations, the third circle, that of the hundreds, takes not less than 1000 years in going once round. Finally, the last circle, which expresses the thousands, will not finish its revolution till the lapse of 10,000 years.

Arrived at that epoch, the movement of the mechanism for computation would not be interrupted, seeing that the principle according to which it has been constructed has no limit; in order to go beyond the year 9999, it will be enough to place the digit 1 before the circle of the thousands; and thus we should obtain the series of the following 10,000 years; then to replace it by the figure 2, for the purpose of having a new series, comprising the years from 20,000 to 30,000; and to continue to do the same each of the 10,000 years, provided the metal would endure for an amount of time so prodigious!

2. The solar cycle is a revolution of 28 years, after which the days of the month return to the same places as the days of the week. This period has received the name of the solar cycle, because it was anciently employed in finding the "day of the sun," or Sunday.

3. The Lunar Cycle, is a revolution of 19 years, during which, according to the assertion of the ancient astronomers, the new and full moons ought to take place in the same order, and on the same days, as they did 19 years before. This cycle is still called the golden number, because at the time of its discovery, 432 before the Christian era, by Meton, an Athenian, the Greeks, when assembled at the Olympic games, decided that the figures which express it, should be engraved in golden characters upon the public buildings. The solar cycle is only true for the Julian calendar; in fact, it would be interrupted each time that the secular year was not a leap year; on the other hand, the lunar cycle is erroneous by one day in every 304 years nearly; these irregularities are provided for in the clock, the mechanism for the computation containing all the modifications introduced by the Gregorian calendar, and all the lunar equations necessary for their rectification.

4. The Roman Indiction is a revolution of 15 years, which, with the solar and lunar cycles serves for the determination of the great Julian period.

Under Constantine the Great, and under his successors they employed in the tribunals and in the revenue offices (the cycle of 15 years) these cycles were periods for the laying on of taxes, &c., and began on 20th of September, 312 of our era. These indictions are still employed in the acts of the Court of Rome, and in those of the Senate of Venice.

5. The Dominical Letters are those which, in perpetual calendars, mark the Sundays.

For this purpose, the first seven letters of the alphabet are made use of to designate the days of the week, and successively the Sunday. These letters, which are arranged for a common year, or for one of 365 days, change each year by going back one letter; for the year having one day more than 52 weeks, two consecutive years can never begin with the same day of the week. The leap years have two dominical letters, of which the first serves from the begining of the year, till the end of the month of February; and the second, from the 1st of March till the 31st of December.

6. The Epacts (so named from a Greek word, which signifies to super-add), indicate the number of days that are added to the lunar year (which is only about 354 days) in order to equalize it with the civil year, composed of 365 days. This number, which most frequently consists of 11 days, is the epact of the year, at the commencement of which it marks the age of the moon on the 1st of January.

This period is far from being regular; it experiences an exception in the secular years (the even hundreds) which are not leap years; it may be thus, 10 in some cases and 12 in others; it may besides be interrupted by the nature of the golden number. Besides these exceptions, the epacts are, moreover, liable to other irregularities, all of which have been introduced into the computing machinery.

7. Finally, Easter Day, upon which depend the greater number of the moveable feasts of the year, is obtained in due course from the elements of the computation; the determination of this great feast, was arranged in the Council of Nice, held in 325. According to the decision of this great synod, Easter among Christians, ought to be celebrated on the first Sunday after the full moon which follows the vernal equinox.

This festival cannot therefore happen either earlier than the 22d of March, the equinox being fixed on the 21st, or later than the 25th of April.

In fact, if the full moon falls on the 20th of March, in which case it is not a paschal moon, the following full moon will take place on the 18th of April; now, if this day is a Sunday, Easter cannot be celebrated till the Sunday after, which corresponds to the 25th of April.

Although this feast cannot fall except on 35 different days, its return is not quite periodic, that is to say, does not take place in an order already passed through. Each year, on the 31st of December, at midnight, the ecclesiastical computation will be set free by the clock, in order to be put in motion, and to determine all the indications of the cycles relating to the new year. These indications being obtained, they serve of themselves to regulate the mechanism of the principal computing apparatus, so as to fix Easter day for the same year. This festival, instead of being represented on the computation work, acts directly on the calendar, where it serves as a means of introducing the other moveable feasts of the year, which depend upon it.

The mechanism placed by the side of the calendar, and to the right of the spectator, bears the inscription, "*solar and lunar equations.*" This portion, one of the most remarkable in the clock, serves—first, to effect the conversion of mean into true solar time,—secondly, that of the moon's mean longitude into its true longitude,—thirdly and finally, that of the moon's nodes, in order to obtain the latitude of this luminary. These conversions are effected by the aid of several pieces of machinery, some of which relate to the sun, and others, and by far the greater number, to the moon, and represent the greater part of its irregularities. In fact, on the one hand, the moon does not gravitate merely towards the earth,—she having a tendency towards the sun; on the other hand, she does not describe simply a circle, but an orbit, of an elliptical form, very irregular and very variable; which orbit is, besides, inclined to the plane of the ecliptic; again, the earth is not in the centre of this orbit, but in one of its foci; finally, the action of the sun, which tends more or less to separate the earth from the moon, varies moreover, according as our globe and that satellite which it carries along with it in its annual course, approach or recede from the sun. From all these causes, one may perceive that the motion of the moon must sometimes be accelerated, sometimes retarded.

The principal of these irregularities are represented by the following equations.

1. The Equation of the Centre.
2. The Evection.
3. Variation.
4. The Annual Equation.
5. The Reduction.
6. As well as the Equation relating to the Moon's Nodes.

The mechanism of these equations is visible behind a handsome plate glass. A piece of machinery still more remarkable, which is placed in the interior of the clock, is destined to convert into the moon's right ascension the true longitude obtained by all the equations relating to this body.

The equation of time is produced by the anomaly, in order to obtain the true longitude, which, in its turn, is converted into true right ascension. The pieces of machinery, which form this part of the clock, have allowed by their perfect execution, the representation of the apparent motion of the sun and moon to be made with a precision truly remarkable; and that for an indefinite time. These pieces of machinery act by their results upon the apparent time, by causing to enter into the indications of this time, the irregularities or perturbations to which the sun and the moon are subject.

(To be continued.)

METEOROLOGICAL OBSERVATIONS,

Taken at 9 A.M., May, 1861.

Gray's Inn Road.

Remarks.

The general state of the weather is denoted by letters, signifying:—b, blue sky; c, clouds; f, fog; h, hail; l, lightning; m, mist; o, overcast; q, squalls; r, rain; t, thunder; r r, much rain; f f dense fog.

The fall in the barometer and the small difference between the dry and wet bulbs (thermometers) presaged the rain which fell on the 3rd; while the increasing difference between these thermometers during the day, indicated that the wind would blow stronger, the barometer continuing to fall; and at 5 p.m., barometer being 29·973, dry bulb 56°, wet bulb 52°, the wind was N, force 7, and the weather fine.

A very severe hail squall, from the N, with the force of about 10, occured at 1 p.m. of the 4th. The temperature fell during the squall, which only lasted about 10 minutes, to 40°. The barometer was 30·124, but it rose quickly after the squall had past.

On the 7th, the barometer commenced to fall, and read 29·590 at 3 p.m. of the 11th, being the lowest observed. During this time there was rain and fog.

The highest barometer was at 9 a.m. of the 20th. On the 23rd at 7½ p.m. lightning, thunder, and rain, occurred lasting about 15 minutes, bar. 29·96. On the 25th at 5½ p.m. barometer was 29·763, dry bulb 62°, wet bulb 55°. For this fall and so great a difference between the thermometers, rain was not to be expected; the wind was S.W., force 7, and the weather very fine.

The barometer has been high during the month, the mean of the 9 a.m. readings being 30·109, and the extreme range observed ·84 of an inch only.

The average temperature for May, as determined from the Greenwich records, is 53°. It will, therefore, be seen that the temperature of the latter part of the past May has been above the average, while that of the first part was below it. Indeed, the temperature has been extreme and variable. The nights have been for the most part cold, and some days have been very hot.

Rain fell on 10 days only, and the amount was small. This deficiency of rain is the natural consequence of the prevalence of dry north-easterly winds. Referring all the 9 a.m. wind observations to the four cardinal points it appears that the wind blew from the N 13 times; E, 6; W, 9; from the S not at all; and the air was calm on three occasions.

N.B. *All* the barometer readings, given in these monthly papers, are reduced to 32° Fah., and the mean sea level. R.S.

EQUATION OF TIME TABLE

For July 1861.

Day of the Week.	Day of Mnth.	At Apparent Noon — Equation of Time to be *added* to Apparent Time.	Difference for One Hour	At Mean Noon. — Equation of Time to be *subtracted* from Mean Time.
		m. s.	s.	m. s.
Mon ..	1	3 29·17	0·478	3 29·13
Tues ..	2	3 40·63	0·467	3 40·60
Wed ..	3	3 51·82	0·455	3 51·79
Thurs..	4	4 2·74	0·442	4 2·71
Fri. ..	5	4 13·35	0·428	4 13·32
Sat. ..	6	4 23·63	0·414	4 23·60
Sun. ..	7	4 33·57	0·399	4 33·54
Mon...	8	4 43·14	0·382	4 43·11
Tues ..	9	4 52·30	0·365	4 52·27
Wed ..	10	5 1·05	0·346	5 1·02
Thurs..	11	5 9·35	0·327	5 9·33
Fri. ..	12	5 17·20	0·307	5 17·18
Sat. ..	13	5 24·57	0·287	5 24·55
Sun. ..	14	5 31·44	0·266	5 31·42
Mon ..	15	5 37·81	0·244	5 37·79
Tues ..	16	5 43·67	0·222	5 43·65
Wed ..	17	5 48·99	0·199	5 48·96
Thurs .	18	5 53·76	0·176	5 53·74
Frid...	19	5 57·98	0·153	5 57·97
Sat....	20	6 1·65	0·130	6 1·64
Sun...	21	6 4·75	0·106	6 4·74
Mon...	22	6 7·29	0·082	6 7·28
Tues ..	23	6 9·25	0·058	6 9·24
Wed ..	24	6 10·64	0·034	6 10·64
Thurs .	25	6 11·46	0·010	6 11·46
Frid ..	26	6 11·70	0·014	6 11·70
Sat ...	27	6 11·36	0·039	6 11·36
Sun...	28	6 10·44	0·063	6 10·45
Mon ..	29	6 8·94	0·087	6 8·95
Tues..	30	6 6·86	0·111	6 6·87
Wed..	31	6 4·19	0·136	6 4·20

TO CORRESPONDENTS, &c.

All Communications for this Journal should be addressed to the Editor, *at the Office,* 35, Northampton Square, Clerkenwell.

N.B.—All Advertisements to be inserted in the Journal must be forwarded to W. Hislop, Honorary Secretary, at the Office 35, Northampton Square, E.C. before the 23d of the Month.

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BRITISH HOROLOGICAL INSTITUTE.

OUR INSTITUTE AND ITS PROSPECTS.

It has often been a subject of remark, both among themselves and by others, that all important objects are attained by Englishmen in their own country on the principle of voluntary association. In other lands and beneath another regime, the patronage of the ruling power is essential and requisite, not only for the maintenance of vitality, but absolutely for the germination of any great idea. In England, every thing is done by societies or companies; abroad, by the bureau or department. Among us, each object so sought after stands upon its own merits, combined with the ability and energy of its promoters. It may probably meet with opposition by many, and be misunderstood by others, but the scheme must look within itself for the life which is to enable it to bear up against all difficulties, to maintain its position and effect the end desired.

The British Horological Institute may be considered as a good illustration of these remarks. Abroad, the government can establish horological professorships, and patronize horological exhibitions; but here, we do all ourselves, and are content so to do. Being willing to help others, we are helped ourselves; and in this union we shall ever find our strength.

The position of the Institute at the present time must be considered as a satisfactory one. A rigid examination of every matter connected with it has been made, the result of which shows that its stability is assured; and that it has reached a point from whence it may look for increased power to carry out its objects for the good of the profession generally. We may be permitted to state, for the information of the public, that a careful examination of assets and liabilities up to the end of June,—an examination by the bye, which ought to be periodical in all societies,—has shown a balance in the favour of the Institute to the amount of more than £300. Half of this sum consists of available assets in the shape of Subscriptions and other sums due to the Society, and the rest consists of books, specimens, furniture, and other property which belongs absolutely to the members. A copy of the statement in detail is deposited in the Office for inspection.

At a period of the year when all similar societies are gathering up their strength for the campaign of another session, we may perhaps briefly indicate the probable work soon to be commenced.

To begin at the beginning, the Classes are likely to be further developed, on a system which will work without risk to the funds. They are to be self-supporting; and beyond a certain point, if increasingly prosperous, will be a source of income to the Institute. The advertising columns will show the proposed arrangements in detail. There are many gratuitous Lectures promised; two of these are "On the Pendulum," by one of the Vice-Presidents; there is a course of ten "On Mechanics," by another Officer; and others are proposed, on subjects of great interest.

We would, in conclusion, especially direct the attention of Members to the Museum. Arrangements are being made to render it more useful as a depository for specimens of interest, and also for examples of different manufactures; and it is particularly desired, that this object may be furthered by the loan or gift of series of objects illustrative of progressive steps in the completion of any kind of horological machines.

W. HISLOP, *Hon. Sec.*

ARTISTIC BOTANY: ITS APPLICATION TO THE LAWS OF ORNAMENTATION.

By Dr. C. Dresser, F.L.S., F.E.B.S.

Lecturer at the South Kensington Museum, the Crystal Palace, the Polytechnic Institution, and the Metropolitan Hospitals.

Second Lecture.

Delivered for the British Horological Institute, *at the Parochial School Rooms, Amwell Street, Clerkenwell, on the Evening of February 15th,* 1861.

Mr. E. D. Johnson, V. P., in the Chair.

(*Continued from page* 135.)

We have also plants which present ornaments which are known as "diaper patterns." These differ in this respect, that the little parts are connected together. There is in all the parts a near relation the one to the other. I do not give these as specimens of beauty, or as by any means the best specimens which could be selected. They are those which come to hand just at the moment without a thought. Here the parts of the pattern are connected, whereas in the other instance they are disconnected.

There is another class of pattern suggested, which we may term a running pattern, of which this is an illustration. They are repeated continuously for any length; not spread in every direction, but pursuing their own way.

Then we have another class of patterns, which have a more extended floral pattern. They have large lumps of flowers aggregated together, or large masses of leaves arranged together in a particular manner, but which are still referable more or less to this type which I have given you.

This feature is strongly suggested by a consideration of the vegetable kingdom, namely, that vertical patterns differ very materially from horizontal or floral ones. This we may apply practically, by saying that a wall pattern differs very materially from a floor pattern. I only use those two surfaces for illustration. They differ in this particular, that the wall patterns, allowing such an expression to be applied, are repeated the wrong way upwards; the floor patterns never do. If we take a tree, it has a right and a wrong way upwards; except with some persons in London who set them wrong. But this little accident would not be mistaken if the whole tree was present. But in this floor pattern, there is no right and wrong way upwards. There is no necessity, at least, that they should be upwards; they may be so or not, The pattern would be upon the floor, where there is no right and wrong way upwards. I may take, as an illustration, a geometrical character of such a simple form as this. That is a good form for a wall pattern, and it has a right and a wrong way upwards. That would be applicable to a wall but not to a floor. In my opinion, persons make a very great mistake in this point. We see continually upon carpets, patterns with a right and a wrong way upwards. To my mind, it matters not which way the carpet is placed; and yet I have heard ladies discuss the point with great warmth. Some say that the pattern ought to proceed from the fire-place; others maintain that it ought to go from the door. The fact is, neither is right, because the pattern ought to go in every direction equally. I should be almost afraid to walk on a carpet with the wrong direction; for whenever it was the wrong way upwards I should feel I do not know how. That very shape I use simply for illustration's sake, supposing it to be applicable to a wall. The principle might be deduced from the point from which it is viewed. Such a one as this might be good applied to a floor. You will find that it will repeat without any space. It has no right and wrong way upwards, and consequently it would be quite suited for a floor, whereas it was before only legitimate for a wall. If it is the prerogative of art to take hold of the most welcome feature and object, to impress with flatness should be the great character both of the wall and the floor. If we walk over a common, we invariably avoid all plants that are large. We never think of walking over a furze bush, or some large plant which casts a beautiful shadow, nor do we attempt to stride over it. They say that a crab will go over a house or anything that lies in his way; but that is not the case with man; at any rate he tries to avoid all these things. My own view of things is this, that certainly the gorse of a common is not an agreeable thing to walk over. We do not like to roam over extremely long grass; that which we feel pleasure in walking over is the short description. This is so with the velvet pile of carpets; we love to feel them soft under our feet. Ladies have a trick of making them feel very soft, by putting hay underneath them ; but I do not know that I ought to let the cat out of the bag on this point.

The short grass is so like the velvet pile; but directly a big plant comes in the way in the moors, we try to avoid it. If it is the prerogative of art to take hold of the most welcome feature, sure am I that it is extremely false to draw a pool of water or a pond, on a carpet; so that when we walk across it our foot appears to go down into some remarkable hole or other, or we do not know whether we are going to be drowned or not. The only thing that makes this tolerable at all, is the want of success in artists in such imitations. I have been in a hut in Ireland, where there has been a fine puddle of water in the middle for the ducks to swim in.

As I happen to know the inventors of those velvet-piled carpets, Messrs. Crossley Brothers, I could not help expressing to them how I was struck with this one fact, that their giving the world those rugs brings them in £90,000 a year for the patent right, still they had too good a taste to put anything into them except as a picture. They have a beautiful drawing worked into one of their own hearth rugs in their own house. You will see the bearings of all this in our subject presently. We have now to ask ourselves this question: Which view ought to be taken of the watch? Should it be vertical or horizontal? I am not talking about a horizontal escapement, respecting which I hardly know anything. I think it is perfectly legitimate to decorate a watch in both ways. I am not talking now of a "a horizontal escapement," such as you use. I think it perfectly legitimate to decorate a watch in both ways, for this reason, because it contains a form which at once suggests a circular and radiating treatment, and it is commonly held in an upright position to the figure, so that we get a starting point at the top. There is at the top a hoop, on which to hang it. The way to decorate it legitimately, is either vertically or horizontally. After due reflection, I say that that is of great importance, because it gives a double chance. If I was dealing with a wall, I should invariably use a pattern which had a right and a wrong way upwards from the floor. I never will have a pattern with a right and a wrong way upwards; but in decorating a watch, we should do it in this way. If I was decorating, I might use a simple radiating treatment, which will exactly correspond with the circular form of the watch. We apply the principle which we noticed last week, as existing in plants, to the purpose of ornament. Let me call your attention to those facts which we noticed as prominently present, namely, the principle of repetition. You will remember, that I called your attention to the fact, that a plant consists of a number of like portions. That is, cutting through the stem here and here, and cutting across there and there, and so on, we divide it into a number of similar portions; so that the whole plant may be said to consist of the same parts repeated. We also noticed that the growth consisted in nothing more than a repetition of parts similar to those already existing. Such things as ferns offer no exception. I have now to notice, that repetition is one of the great features in ornamental decoration. Without it, we should be debarred of that one principle which, perhaps, gives us the greatest freedom in the production of beauty. You must even remember that the decorations of musical compositions, more beautiful than any other, are continually repeated. If we have any little charming bit of music, we commonly find that the ear is incapable of fully appreciating it when passed over for the first time. That is a principle adopted by some of our best authors, they repeat the same idea in a vast number of ways. I was struck with illustrations of this principle in the discourses of the late Dr. Beaumont. He would take six or eight different ideas, and repeat them over and over again in different words, with just a little modification, just to make it theologically correct and he would in that way produce a certain amount of beauty. As an illustration of the way in which repetition will do the same thing in ornamentation, I may point you to the kaleidoscope. As commonly used, you turn about little bits of glass. Those which are most beautiful, commonly contain nothing else; and yet they produce a vast amount of beauty, all arising from this principle of repetition. Write a few words in ink, and rub it about, and you will have some beautiful things produced by repetition. But while I state repetition to be the great feature in botany and ornamentation, do not suppose that I wish you to leave out all mind. I merely use this as an illustration of what repetition will do. If I repeat a beautiful form, it is a developement of some new idea. You get a vast number of beautiful things from that favourite designer, the kaleidoscope alone; but fancy what an intellectual employment it would be to turn it about, until you got by chance a good pattern, and then to copy it. That is a perfectly non-intellectual employment. The kaleidoscope consists of a few pieces of coloured glass, put in a frame in an equilateral or triangular manner; by its instrumentality you will get a very good hexagonal pattern, which is always more or less beautiful. An elongated series is specially

adapted for bordering. Here are several specimens; but they may all be resolved into a circular treatment running round anything; but take an elongated series of that kind and twist it round. You may have a repetition of crosses or spots on anything. The lady portion of this assembly will, perhaps, remember that about ten years ago there was a great fashion for a certain pink dress with spots on; the parts consisted of that variation of nothing but repetition. It was a class of patterns which we term "powdering." Then we have repetition occurring in the form of diapers, Here is a plant very familiar to ladies, the mistletoe; we, of course, do not know anything about it. •However far it grows inwards, it will be just a repetition of what has already been produced. The mistletoe grows outwards by that sort of extended repetition.

Then there is a specimen which is not absolute repetition, which I ought perhaps to call your attention to, manifested in such things as this. Although every one of you is familiar with the plant, from which that little leaf of a flower is taken, it is possible that not one of you may happen to know what it is. I am not one whit more clever than the rest of you, because I never saw it until I was told that it was the leaf of the flower of mignionette. As it happens to be so small, and the leaf is divided into a number of little portions, we regard it as nothing. It is a plant which has a very agreeable odour, but we forget to look at what shape the flower is, and what sort of repetition prevails in it. The Egyptians had an ornament of somewhat similar form, involving exactly the same spiral repetition, with slight modifications. In the Moorish decorations, also, there was a similar ornament. Amongst the Gothic ornamentalists, there was a similar mode of treatment; and so we could treat it through every great historic period of art. It possesses that one peculiarity which ornamentalists of every age have felt to be pleasing, that single principle of repetition.

There is another law which I must notice; but I can only devote one word to it, and that is, what we term the law of alternation. I called your attention to it in illustrating this diagram last week. That where there are pink leaves in the flower, there will be a filling up of green leaves. That is a feature of immense value in an ornamental point of view. Here is a little ornament; behind it are placed these four green points. Here again is nearly the same thing, only these little green points alternate with these, which fall between them. Any child would at once pronounce these to be more beautiful than those. This has something pleasing, which the other has not. That law of alternation is a law of beauty. The principle may be disguised to a certain extent, or hidden in a beautiful manner in ornament, but it must be acknowledged. The two simple little ornaments of a very simple character which are here represented, are taken from an ancient warming-pan. Here it appears indented with some sharp instrument. Our most distinguished ornamentalists in every age, have felt that principle on which plants grow to be essential to beauty. Here every figure takes up the same idea. I have noticed in some of the best works most ingenious contrivances for giving this effect of alternation.

(To be continued.)

A BRIEF DESCRIPTION OF

THE ASTRONOMICAL CLOCK OF THE CATHEDRAL OF STRASBURG.

By Charles Schwilgué.—Strasburg, 1844.

(Concluded from page 139.)

7. The part which is above the calendar is devoted to the days of the week.

In the midst of clouds, there is seen, upon a projection in the form of a celestial vault, each of the seven pagan divinities whose names have been given to the ancient planets. These allegorical figures appear seated in chariots of shapes at once graceful and varied, the wheels bear the name of the divinity and that of the day. These chariots, drawn by different animals that are assigned as attributes to each of the divinities, run upon a circular iron railway in a continued motion.

On Sunday, is seen Apollo, or Phœbus, the god of day, upon a radiant chariot drawn by the horses of the sun.

The chaste Diana, the emblem of the moon, makes her appearance on Monday, seated in a chariot to which is yoked a stag with timid gait.

She is succeeded by Mars, the terrible god of war, whose chariot drawn by a high mettled horse, is ready to rush to the combat.

Mercury, the crafty messenger of the gods, bearing at the same time the caduceus and the purse, shows herself in the middle of the week.

Jupiter, armed with the thunderbolt, although the master of the gods and sovereign of Olympus, has only his turn on Thursday.

Friday is consecrated to Venus, the goddess of beauty. She appears accompanied

by her boy Cupid, in a light and graceful chariot drawn by gentle doves.

Last of all appears Saturday, the day of Saturn; the god armed with a scythe, and upon the point of devouring an infant, symbolizes Time, which devours everything, and which nothing can resist.

On the two sides of the projection devoted to the divinities of the week, there are depicted in a happy manner, and as though by way of a religious corrective, several paintings by Tobias Stimmer. They exhibit the grand scenes of the creation, the resurrection, the last judgment, and the final triumph of faith and virtue. Moreover, there are two admirable pictures of religion and sin, represented under the forms of two young women; the first of whom, with maiden deportment, is altogether occupied with her own salvation; whilst the second, plunged in vice, has already lost a great part of her youthful bloom. These fine paintings are accompanied by different verses from the Bible, that relate to these subjects.

8. We now arrive at the Gallery of the Lions, so named because the two ends of this gallery or balcony are guarded by two of these superb animals, one of them holding in its claws the escutcheon, and the other the crest of the arms of the town of Strasburg. These lions, carved out of solid wood, came from the ancient clock, in which they never had any motion, and in which they never made the least noise, although some persons persuaded themselves that they roared. A sound of this kind would have been both disagreeable and very inconvenient in the interior of the church. The centre of this gallery is occupied by a small dial-plate, intended to indicate the *mean time*, that is, the time which is composed of hours all of an equal duration, holding a medium between the longest and shortest true solar hours. The central mover of the clock communicates directly to the pointers of the *mean time* the motion requisite, whilst the two other kinds of time, of which mention has already been made, namely, the sidereal time and the apparent time, only come into operation by means of machinery expressly adapted to modify the speed which is transmitted to them by the central mover; a mover which is only wound up once in eight days, and which is one and the same for the entire clock.

9. Upon the Lion's Gallery there are, besides, two genii seated at the two sides of the dial plate of the mean time.

The genie placed to the left of the spectator, holds in one hand a sceptre, and bears in the other a bell, upon which he strikes the first stroke of each quarter-hour; the second being repeated as we shall see by one of the four ages that we shall find higher up. One would say, on seeing the careworn aspect of this genie, that it is deeply affected by the serious nature of its duty, being employed to give to the four ages the signal each time they have to appear.

The genie seated on the other side, holds in its two hands an hour glass filled with red sand, which it reverses every hour; at one time half a turn to the right, at another time by half a turn to the left. It produces this motion in a manner equally graceful and natural, each time at the last stroke of the four quarters, an instant before Death sounds the hours.

10. The story above the Lions' Gallery is, in a great measure, occupied by a *planetarium*, constructed after the system of Copernicus.

The revolutions of the planets visible to the naked eye, are represented upon a large dial-plate, whose azure ground imitates the colour of the sky, at a great height. A gilt disc, representing the sun, occupies the central part of the planetarium. This disc is not held up by any support; from its centre proceed twelve rays, which end at the signs of the zodiac, painted on the outer edge of the dial plate. Seven small gilt spheres, having different shades, imitating those of the planets, and having their diameters proportional to the apparent dimensions of these heavenly bodies, move in the order of their position round the sun, which remains unmoved in its own place.

Close to this body is seen Mercury, proceeding through his entire orbit, in about 88 days; immediately after comes Venus, the morning star, the most brilliant of the planets, whose entire revolution is performed in about 225 days.

The earth, which occupies the third place, finishes its course in 365 days, 5 hours, 48 minutes, and 48 seconds.

Beyond our globe, there is first of all Mars, the first of the planets called superior, in opposition to the two preceding, who are called inferior, as being between the sun and the earth. Mars, of a reddish colour, finishes his revolution in about 687 days. After him comes Jupiter, who finishes his in nearly 4330 days. Last of all follows Saturn, the last of the planets visible to the naked eye, which is no less than 10,747 days in his passage round the sun.

A faithful interpreter of the movements of each of the planets in the celestial system, the planetarium moreover represents the revolution of the satellite of the earth, and we thus see our globe continue to pass along

its orbit, whilst the moon at the same time turns round it, making an entire revolution in the space of a lunar month.

At the four corners of the planetarium are painted, in a very expressive manner, the seasons of the year, Spring, Summer, Autumn, and Winter, represented by the four ages of man.

11. Above the planetarium is seen, upon a star-decked sky, a globe specially devoted to showing the *phases of the moon*. By turning on its axis, this globe, which is inclined, becomes illuminated and obscured according to the different appearances which it ought to show during the period of a lunation. In the new moon, this globe shows us its darkened portion, and thus renders the moon invisible to our eyes; at the end of the twenty-four hours or so, we may begin to perceive a slight portion, or thread of light, which, enlarging little by little ends on the seventh day by becoming the first quarter. The following days show the augmentation of the enlightened portion, till it presents to us its brilliant half, that is, till it becomes full moon. In continuing to turn upon its axis, the globe seems to us to grow less in its luminous portion; the bright part gradually diminishes, and, at the end of seven days, shows us no more than one-half of the enlightened hemisphere.

After this last quarter, the luminous disc finishes by disappearing entirely, at the moment when the moon terminates the synodic revolution; or when she has returned to the same situation in respect to the sun. In fact, the moon, after having completed its revolution round the earth in twenty-seven days and a half, still requires about two days in order to come opposite the sun and in conjunction with that body.

Above the space reserved for the moon, there is a Latin inscription, which may be translated thus—"What is similar to the dawn, beautiful as the moon, and radiant as the sun?"

At the same height are two paintings, of which the one, under the features of a woman, represents the Christian Church, with these words, "Ecclesia Cristie exulans;" the other, under the the form of a hideous dragon with seven heads, represents Antichrist, with this motto, "Serpens Antiquies Antichristus."

Not far from this, are the two dates MDCCCXXXVIII. and MDCCCXLII., the former indicates the year in which the mechanical works of the clock were commenced; and the second, that in which the clock began to go for the first time.

At the two sides of the hemicycle which surmounts these paintings, there are sculptured in the stone—on the right, a griffin, on the left, a fantastic animal, half-lion half-bear, supporting escutcheons.

12. Next comes the moveable statuettes or automatons, which have more especially the privilege of attracting the attention of the multitude.

These automatons appear in two distinct compartments, both of them representing chambers with ogival arcades. The four ages of human life, and death, which are employed to sound the quarters and the hours occupy the lower part.

Four small figures, whose movements imitate nature, appear, in turn, to sound the quarter-hours—the second stroke alone of which they render audible, the first being struck by the genius with the sceptre, which we met with in the Lions' Gallery.

At each hour, the child commences the procession, and announces the first quarter by means of a thyrsus, which he allows to fall upon a bell. He is followed by a youth who, in the form of a hunter, strikes with his arrow the half-hour. Afterwards there comes a man, under the figure of a warrior who is clad in iron and armed with a sword, which he makes use of to sound the third quarter of the hour. Finally, a moment before the hour strikes, one may see the old man arrive, who, warmly clothed and with drooping head, leans upon his crutch, with which he sounds the four quarters. Each of these small figures, on coming out of its apartment, takes two paces in order to come near to a bell which is suspended close at hand; having arrived there, it stays the time necessary for striking the number of strokes wanted, after which it disappears to make room for the automaton which comes after. Death armed with a scythe, stands upon a (socle) slab in the midst of the room reserved for the Four Ages. At the completion of each hour, this hideous figure is observed gravely to let fall on the bell at his right the bone which he carries in his hand. Indefatigable, he watches day and night, sounding the hours without cessation. The four ages, on the contrary, symbols of mortal men, only perform their duty during the day.

13. The upper apartment, more richly decorated, is occupied by the figure of Jesus Christ who rises super-eminent in the centre. Placed on a pedestal, the Saviour of the world holds in one hand the banner of redemption; and stretches out the other to give his benediction. Each day, at the instant when Death strikes the last stroke of twelve at noon, there are seen to pass at the feet of Christ, his disciples, to the number of twelve, namely: Peter, John, James the

Greater, Andrew, Bartholomew, Philip, Simon, James the Less, Matthew, Thomas, Jude, and Matthias. Each of the twelve apostles, bearing the instrument of his martyrdom or the attribute by which he is distinguished, advances respectfully. Having arrived before his divine master, he turns towards him and bows his head as a sign of salutation; he then withdraws to a distance, after having received the benediction, which is similar to that which Abraham must have given to Isaac when this patriarch went into the land of promise. It is not till after the departure of the last of the apostles, that Christ gives the benediction by making the sign of the cross. Although some persons think they have seen the apostles in the ancient clock, this scriptual procession, however, never existed in the work of Dasypodius. Instead of this beautiful scene, there was observed Christ placed opposite to Death, who at each hour caused his divine antagonist to draw back.

14. During the procession of the apostles, the cock perched at the top of the turret for the weights, sends forth his crow of victory; but, before allowing his voice to be heard, he flaps his wings, his head and his tail move, and his neck ruffles up to allow the sound to escape.

This cock has been executed after nature; it is as large as that which figured in the two ancient clocks; every day, at noon, it crows three times in remembrance of the crowing which resounded in the ears of Peter in the Pretorium, after that apostle had denied his master.

15. The dome, which crowns the case or chamber of the clock, is remarkable, as well for the elegance of its form as for the richness of its ornaments. The centre of it is occupied by the statue of the prophet Isaiah, from the chisel of our celebrated sculptor M. Grass.

Around Isaiah are grouped the evangelists, St. Matthew, St. Mark, St. Luke, and St. John, accompanied by the different animals that are assigned as attributes to them. A little higher up, there are four seraphims, who, upon different instruments, celebrate the glory of God. Last of all, the dome is surmounted by the herald of the Association of Masons (stone cutters) of the cathedral, with the coat of arms of the Virgin (l'Œuvre Notre] Dame.)

16. The turret for the weights, the cupola of which is surmounted by the cock, offers to our attention several paintings derived from the ancient clock. The first in a descending order, represents Urania, one of the nine muses, and who presides over astronomy; she appears in the form of a young girl, dressed in an azure coloured robe, and crowned with stars: she holds a globe in one hand and a pair of compasses in the other.

The second is a colossal allegorical figure of the four monarchies mentioned in the seventh chapter of Daniel. This is the figure of a warrior with a crown on his head, and holding a sceptre in his hand. Lastly, the third gives us the portrait of Nicholas Copernicus, to whom many authors have attributed the construction of the clock of the sixteenth century; although this celebrated astronomer was never at Strasburg, and that work was only begun 30 years after his death.

Upon the face of the turret, towards the choir, are painted the three Fates:—Clotho holding the distaff, Lachesis turning the spindle, and the pitiless Antropos, who cuts the thread with her scissors.

Upon one of the panels of the opposite face there are painted the attributes of the different trades that have assisted in the construction of the clock.

17. To the right of the spectator is a spiral staircase, that serves at once to lead to the different stories of the clock, where the moving powers are situated, and to give access to the small balcony whence we can see the exterior clock chamber, and judge of its entire height, which is not less than 20 metres ($65\frac{6}{10}$ feet). From this smaller balcony, we arrive at another flight of stairs, of a construction remarkable for its lightness; this flight of stairs, made of iron, leads to the Gothic dial-plate which faces the royal palace.

18. Above the principal entrance, where the large dial-plate was, which was destined to show, in the square of the cathedral, the performance of the clock, there is at present a beautiful dial-plate in the Gothic style, fitted into the ornaments formerly used, and surmounted by a gallery of stone, one of the handsomest in the building. This dial-plate whose circumference is about 16 metres ($52\frac{1}{2}$ feet), is furnished with two pointers, also of a Gothic form, serving to indicate—the one the hours and their sub-divisions, from five minutes to five minutes mean-time, the other the days of the week as well as the planetary signs which correspond to them.

19. As the building of the cathedral is not strictly east and west, it has been found practicable to fix a meridian line in the interior of the church, in proximity to the clock. The line indicating the south, placed against the entrance-wall, is shone upon by a solar ray which traverses the gnomon placed above the door; thus we may compare in a most convenient manner the pro-

gress of the clock with the irregular progress of the sun: since at one glance we can observe, at the same time, the indications produced by the machinery and those of the luminary which serves to regulate them. Advantage has been taken of the hollows or recesses in the wall, not far from the meridian line, for placing there the tablets, one of which bears in golden letters the names of the authorities under whose administration the clock was finished; whilst the other gives the principal pieces of mechanism of which this work is composed.

20. The moving powers which propel the different portions of the clock, are set up in cases on the ground floor, and on the two storeys, where by the means of transmissions they receive the movement imparted by the central mover, which as we have said is one and the same for the entire clock.

This central mover, the execution of which bears the imprint of the nicest precision, depends upon a regulator which beats the seconds, and which is itself regulated by a compensating pendulum and a jewelled escapement. This mover, notwithstanding the small moving force, and although it is wound up only once in eight days communicates its motion,—

1st to the pointer of the dial-plate for mean time.

2d to that of the large Gothic dial-plate.

3d to the planetarium.

4th to the moon in order to represent its phases.

5th to the seven figures of the week.

6th to the pointers of the dial-plate for apparent time.

7th to the solar and lunar equations.

8th and last, to the celestial sphere, to indicate the sidereal time.

It produces, besides, by means of a peculiar mechanism, the suspension of the functions of the four ages during the night, and the renewal of their movement during the day.

The other movers, to the number of five, intended to move the automatons (automata) and to produce the different ringings or peals &c., are in dependence one upon another by means of transmissions of a contrivance equally simple and ingenious.

Thus, when the hour is to be struck the central mover sets free the second mover (or wheel-work of the Four Ages); this in its turn transmits the motion to the third wheel-work, that is to the striking of the quarters: which, in turn, as soon as the quarters are struck carries back the motion to the second mover to set the automatons in motion. When this piece of wheel-work has ceased to act, it communicates the motion to the fourth, in order to strike the hours. Moreover, at noon, a fifth piece of wheel-work, that of the Apostles and the Cock, receives directly its impulse from the mover of the hours.

These different transmissions (or transferences) of one mover to another, as well as their detachments, take place without the least uncertainty and without the slightest noise.

Whilst securing the certainty and accuracy in their operations of the numerous members of the machinery, and of their various transmissions, elegance of form and harmony of disposition have not been sacrificed. Hence the movers and the mechanism, whether taken in their separate parts or as a whole, present an arrangement very pleasing to behold.

It must be remarked that there does not enter into the construction of the clock a single piece of wood, or any easily decaying material. Choice has uniformly been made of the metals which are most durable, and which thus guarantee the preservation of the work.

This clock—the fruit of immense calculations, of toilsome researches, arduous labours—is not, then, as many persons have thought, a mere restoration; it is an entirely new work, both in invention and execution—a work which marks, with equal accuracy, seconds and periods of time exceeding twenty-four thousand years.

The following Note is appended at the end of the Original:—

We here end our notice; and for more ample details, we refer to the description which will appear in a short time. In this new work we shall not confine ourselves to describing the ancient and the modern clock; but in addition we shall introduce the biography of the men who have contributed to these works; as well as an account of the *fete* given to my father on the 31st of December, 1842, on the occasion of the inauguration of his clock.

British Horological Institute.

New Members.—The following Gentlemen have been admitted as Members of the British Horological Institute during the past month:—

Messrs. Hall & Co.; Arthur Trevilian, Esq., J.P.; Messrs. Glasgow, Johnson, and Armstrong.

Notice.—The Members whose Subscriptions are due at Midsummer will oblige by paying them at the Office, or forwarding them in Postage Stamps or by Post Office Order to the Honorary Secretary.

Erratum.—We regret to state, that the Vote of Thanks to Mr. Farmer, the Editor of the "Clerkenwell News," at the the last General Meeting of the Institute, was inadvertently omitted in our last Journal.—Ed. H. J.

METEOROLOGICAL OBSERVATIO

Taken at 9 A.M., June, 1861.

Gray's Inn Road.

REMARKS.

The letters descriptive of the general of the weather signify: b, blue sky; tached clouds; l, lightning; m, mis overcast; r, rain; t, thunder; rr, much

The average of the 9 a.m. baro readings is 29·991. The highest readi the barometer was 30·24, at 8 a.m. o 13th; the lowest 29·63, at 5 p.m. o 26th; giving a range of 0·61.

The mean temperature for June deduced from the Greenwich records, is During the first eleven days the temper was below the mean, during the rema of the month it has been above.

Rain fell on 16 days, but the quantity not large.

Referring the winds at 9 a.m. to the dinal points, it will be found that a N blew on 10 days; E, eight; S, four eight.

On the whole the weather of June been genial; the atmospheric pressure not varied much; the temperature has a little above the average; the quanti rain considerably below the mean; an... ... very destructive storms have occured. R. S.

EQUATION OF TIME TABLE

For August 1861.

Day of the Week.	Day of Mnth.	At Apparent Noon — Equation of Time to be *added* to Apparent Time.	Difference for One Hour	At Mean Noon. — Equation of Time to be *subtracted* from Mean Time.
		m. s.	s.	m. s.
Thurs..	1	6 0·93	0·160	6 0·95
Fri. ..	2	5 57·09	0·184	5 57·11
Sat. ..	3	5 52·66	0·209	5 52·68
Sun. ..	4	5 47·64	0·234	5 47·66
Mon...	5	5 42·03	0·259	5 42·05
Tues ..	[illegible]	5 35·82	0·283	5 35·85
Wed..	7	5 29·02	0·308	5 29·05
Thurs..	8	5 21·63	0·332	5 21·66
Fri. ..	[illegible]	5 13·65	0·357	5 13·68
Sat. ..	10	5 5·09	0·381	5 5·12
Sun. ..	11	4 55·94	0·405	4 55·97
Mon ..	12	4 46·21	0·429	4 46·23
Tues ..	13	4 35·90	0·453	4 35·93
Wed..	14	4 25·03	0·476	4 25·06
Thurs.	15	4 13·60	0·499	4 13·63
Frid...	16	4 1·63	0·521	4 1·67
Sat....	17	3 49·14	0·543	3 49·17
Sun...	18	3 36·12	0·564	3 36·15
Mon...	19	3 22·60	0·584	3 22·62
Tues ..	20	3 8·59	0·604	3 8·62
Wed..	21	2 54·10	[illegible]	2 54·13
Thurs.	22	2 39·15	0·641	2 39·18
Frid ..	23	2 23·76	0·658	2 23·79
Sat ...	24	2 7·97	0·675	2 8·00
Sun...	25	1 51·77	0 692	1 51·79
Mon ..	26	1 35·16	0·707	1 35·18
Tues..	27	1 18·19	0·722	1 18·20
Wed..	28	1 0·86	0·736	1 0·87
Thurs.	[illegible]	0 43·19	0·750	0 43·20
Frid ..	30	0 25·20	0·763	0 25·21
Sat ...	31	0 6·90	0·775	0 6·90

TO CORRESPONDENTS, &c.

All Communications for this Journal should be addressed to the EDITOR, *at the Office*, 35, Northampton Square, Clerkenwell.

N.B.—All Advertisements to be inserted in the Journal must be forwarded to W. HISLOP, Honorary Secretary, at the Office 35, Northampton Square, E.C. before the 23d of the Month.

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END OF VOLUME III.

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THE

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1862.

The Horological Journal.

VOLUME IV.

SEPTEMBER 1, 1861.

TO OUR READERS.

THE experience of the last year, we are happy to say, has fully realized the prognostic we ventured to give in our last Address, regarding the successful progress of the HOROLOGICAL INSTITUTE. The number of Members is gradually on the increase; whilst, in the departments of the Museum and the Library, as likewise of the Journal, (the sale of which is satisfactorily progressive), a marked and steadily advancing improvement has taken place.

The DISCUSSIONS bearing on Practical Horology, have been distinguished by great acquaintance with useful working details, and by numerous suggestions evincing a spirit of patient scientific research; in proof of this we may advert to the Discussions on the Principles of the Lever Escapement, reported in No. 30, of Vol. III.

In the DRAWING CLASSES (Geometrical, Mechanical, and Ornamental), a new arrangement has been made, by virtue of which these Classes are rendered self-supporting instead of being, as hitherto, a charge upon the funds of the Institute; a change which, it is confidently hoped, will prove conducive to their efficiency. The result of the late examination of the Pupils has been highly satisfactory.

In the LECTURE Department, we may mention the highly useful and interesting series of Lectures delivered by Dr. DRESSER, "On Botany as applied to Ornamentation." The solicitude of the Council in providing for the efficiency of this department, is sufficiently evinced, as no doubt our readers will acknowledge, in the promising Syllabus of the forthcoming Course of Lectures announced for delivery during the current session, in the following page.

That the present Financial position of the Institute is highly encouraging, will sufficiently appear from the official statement on this head inserted in our last number. One of the main objects in the original establishment of the Institute was to foster the introduction of any great International measure for the general improvement of Horological manipulation; amongst other desiderata to this end, the necessity of the adoption of a Universal System of Gauges for Clock and Watchmaking purposes had been long since recognized. By the correspondence and co-operation of the Institute with home and foreign centres of manufacture, the prospect of a speedy solution of this important question now bids fair to be realized. Under the sanction of the Council, a Prospectus, embodying the advantages likely to accrue from the universal adoption of such a system of measurement, has been forwarded in all directions; and we have good reason to hope that the success of the plan proposed is on the eve of its accomplishment.

British Horological Institute.

The Council have great pleasure in announcing to the Members that the following Lectures will be delivered at the Institute during the present Session.

Wednesday, Sept. 18th, " On Recent Improvements in Barometers." R. Strachan, Esq.

October...................." On the Pendulum." (Two Lectures.)......... E. D. Johnson, Esq. F.R.A.S. V.P.

November to March ... " On Mechanics." (A Course of Ten Lectures.)
W. H. Hislop, Esq., F.R A.S. Hon. Sec.

Division First.

Lecture 1.—Introduction : Relation of the Science to Horology—Properties of Matter.
" 2.—Statics—Form—Equilibrium.
" 3.—Centre of Gravity

Division Second.

Lecture 4.—Dynamics—Laws of Motion—Inertia.
" 5.—Second and Third Laws of Motion—Compound Motion—Reaction.

Lecture 6.—Central Forces—Rotatory Motion.
" 7.—Gravitation and Laws of Falling Bodies
" 8.—Gravitation (Second Lecture) Projectiles—The Pendulum—Effects of Gravitation on the Heavenly Bodies.

Division Third.

Lecture 9.—Mechanical Powers: Lever, Wheel, and Axle.
" 10.—Pulley—Inclined Plane—Wedge—Screw.

GEOMETRY AND DRAWING CLASSES.

The Classes will recommence on Tuesday, September 3rd, under the direction of Mr. J. S. Jackson. Students are respectfully informed they will be required to furnish instruments; drawing paper will be provided by the Institute.

The Geometry Class will reassemble under the direction of Mr. R. Strachan, Certificated Teacher of Navigation and Science.

All particulars as to Membership may be obtained at the Institute.

The Council desire to call the attention of members, parents, or employers, to the importance of supporting these Classes, by allowing those under their care the opportunity of attending them. The progress shown by Pupils who have done so has been most satisfactory. As an introduction to more practical acquirements of a mechanical nature, the means of obtaining that sound knowledge of principles which these Classes are intended to afford must be a desideratum of high importance. To further this object, the support of Members is claimed, and it is hoped will be given.

BERTHOUD'S DESCRIPTION OF HIS MARINE TIME-KEEPER, No. 8.

TRANSLATED FROM HIS "TRAITÉ DES HOROLOGES MARINES."

Paris, 1773. *Chap.* x. *page* 271.

The marine watches, which I have hitherto described have shown sufficient accuracy to induce me to continue my labour, but not enough to satisfy me. I was looking forward to a time, a long way off probably, but yet one which we might nevertheless arrive at. The idea of a still greater degree of perfection which I clearly saw to be very possible, induced me to commence No. 8, at a time when chronometers Nos. 6 & 7 were hardly completed. This same watch No. 8 belonged to the king, and had been constructed by his order, and was submitted to trial by Messrs. Flearieu & Pingré during a voyage which lasted more than a year. We shall give hereafter an extract of its rate during this voyage, and before describing it we shall relate upon what principles my hopes were founded for perfecting marine watches: it will be seen, moreover, that those principles are no other than those which we have established in the former part of this work. It will likewise be seen by the various experiments and trials made with this machine, that we may with something like certainty, imagine that horology will one day be very useful to navigation, unless the efforts of watchmakers are stopped by the obstacles that should be thrown in the way of those who are occupied in the discovery.

Of the Regulator of Chronometer No. 8

The balances of the chronometers No. 6 and 7, are 28 lines (in English inches 2·49 diameter), and make four vibrations in a second. Let us examine here what are the proper dimensions to be given to the balance of No. 8 for it to have the greatest power of movement possible (considering the size of the barrel, and where it ought to be placed) so that this power may have the smallest amount of friction. If we cause the balance to make two vibrations in a second and it is of the same weight as No. 6, but double the diameter, then they will each have the same amount of motion, and the same power of movement supposing that they describe the same arcs; but the friction will be as the number of vibrations, that is to say as 4 to 2. It is therefore preferable to diminish the number of vibrations and to augment the diameter of the balance. If the balance makes one vibration in a second and its diameter is four times larger than that of No. 6, they will each have the same velocity of their circumferences supposing the same arc described, and if the balances have the same weight, the force of the movement will be the same, but in this case the balance with a slow vibration will have four times less friction (supposing the pivots and the friction rollers to have the same diameters; this is evident because the weight being the same, the friction will be as the space run over by the pivots, that is to say, as the number of vibrations: slow vibrations and a large balance are a sure means of procuring an excellent regulator. It is after this examination, that I have again come to the slow vibrations which I had employed in my two first marine chronometers. I only abandoned them in the fear lest the agitation or movement of the vessel should tend to derange this sort of vibration, but I have anticipated this defect by giving more extent to the arcs than I had formerly done, and in augmenting the momentum of the balance by increasing its diameter rather than by the weight. Experience has fully justified these principles because in the trials which had been made at sea, it was not thought that the marine chronometer No. 8, would be more susceptible of agitation than No. 6. Another advantage that the large balance ought to procure, is to be able to employ large rollers, preserving nevertheless their pivots the same size; by this we reduce considerably the friction of the regulator or balance. The parts of the axis of the balance which take the place of pivots are of a diameter much larger in No. 6 & 7. I proposed therefore to reduce them as much as possible in No. 8, as a sure means of reducing the friction, since the pressure remaining the same, the space run over is diminished. To employ a large balance, the movement of the chronometer must necessarily be larger in order to contain it; but there results still another means of perfecting it, that is that the employment of bars of compensation longer and more solid and consequently better adapted to compensate the balance spring, an effect of absolute necessity. I applied myself also to simplify and render more solid all the mechanism of the compensation. In the adoption of slow vibrations of a second for the balance of No. 8, we are able to retrench one wheel

Plate XVIII. Fig. 1.

of the movement by making the wheel whose axis carries the seconds hand also that of the escapement. The detached escapement formed by ruby pallets and a steel wheel employed in No. 6 & 7, had succeeded well enough to be adopted for No. 8, and in this case it ought to succeed so much the better as the balance has a greater power, the friction and the escapement supposed to be the same as No. 6, and consequently must have less influence on the regularity of the watch having a balance like that proposed for No. 8. The simple and advantageous disposition of the wheel work of No. 7, must necessarily serve for No. 8, therefore I have not made any other changes than in the dimensions of the wheels and pinions, which I have made larger, on account of the room both to give them more solidity and to facilitate the execution. In the chronometers No. 6 and 7, I had made a special frame for the regulator or balance, which increased the work by two plates and four pillars, and also the labour of adjusting this frame with the large compensation plate. I disposed the new chronometer in such a manner as should enable me to suppress a work which then appeared to me useless. Although the regulator of this new chronometer ought to be pretty powerful and so disposed as to have isochronal oscillations, I did not think on that account that we should abandon the weights as a power. Its properties are too essential to the greatest perfection of a marine chronometer that I should be able to neglect them. I did not apply myself less indefatigably in the research which occupied me to render the suspension as

perfect as it was possible, and above all to prevent the action of the balance giving any motion to the case, sometimes an effect which has taken place, and might disturb the exactness of the chronometer. The following is an abridged detail of the preliminary researches which preceded the execution of No. 8. I have not given them at full length, as in my manuscript books, as that would be much too long for this work, but a predilection which I cannot conquer for this chronometer No. 8, will not permit me to retrench altogether that part which has led me to give it the requisite precision to hope that it will be useful to navigation.

Description of the Marine Chronometer No. 8.

PLATE 18.

The movement of this chronometer, seen in profile (plate XVIII fig. 1) is composed of four large plates, forming three large frames and two small plates, forming the two smaller frames with the friction rollers. The first large plate 1 A A, is that of the pillars of the wheel work. I call it also the dial plate, because it carries the dials o[f] minutes and seconds, and that of the hour[s] appears through an opening which it contains. The second plate 2 BB, makes with that of 1AA, the frame of the wheel work and it is at the same time common with the plate 3 C C, in order to form the second frame which is that of the regulator. The under side of the second plate B B, form[s] with the little plate DD, the frame of the three superior friction rollers of the balance and the upper side of the third plat[e] CC, forms with the small plate EE, the frame of the three lower friction rollers o[f] the balance. The under side of this thir[d] plate CC, carries the mechanism of the com[-]pensation. The fourth large plate is no[t] seen here, being that of the pillar plate fo[r] the weight; and it carries the pillars 4, 5 6, which are connected with the third plat[e] C C, and form the third large frame whic[h] is that for the weight. The surface plan o[f] the pillar-plate for the weight, and its posi[-]tion, is represented in plate XV fig. 2; and a[s] we have given the description (No. 809), w[e] refer to both, since this part of No. 8 bein[g] quite similar thereto, it has been though[t] useless to repeat it. The cord *a* of the weigh[t] passes over the direction pulley F, and thenc[e] passes round the barrel G, borne by the axi[s] of the great wheel of the barrel or that o[f] the hour wheel H. The disposition of thi[s] large wheel is quite the same as that of No 7, explained in No. 681,811, and what fol[-]lows; it makes moreover a turn in 12 hours and bears the dial of the hours placed against [t]he inside of the dial-plate which marks the [h]ours through the opening which this latter [c]arries, as seen in A, *fig.* 2; the dial for the [h]ours is not seen in this figure; to prevent [a]iding the escapement, this wheel bears like [t]hat of No. 7, an auxillary spring *c* placed [b]etween the ratchet *d*, and the large wheel

Plate XVIII. Fig. 2.

H, to make the chronometer go while rewinding; *b* is the square to wind up the large wheel, *d d* the ratchet of the auxillary spring, and I, the click. The hour wheel H gears in the minute pinion *e*, the long pivot *f* bears the hand marking the minutes on a little eccentric dial, B 2; the pinion *e* carries the minute wheel K, this one gears into the pinion *g* of the little third wheel L, and the latter gears into the pinion *i*, the prolonged pivot of which bears the seconds hand marking them on the large concentric dial *c*, *fig.* 2.

The axis of the seconds pinion bears the wheel M M, which is that of the escapement; this wheel is shaped like that of the escapement No. 7 (802), it is of tempered steel, and carries 30 teeth at an inclined angle which act upon the ruby pallets borne by the cylinder *m*; the disposition of these pallets and of the escapement is the same which has been explained (No. 803), so we refer to them.

The superior pivots of the axis of the cylinder *m*, work into a hole of the bar *n n*, borne from outside the dial plate; this little bar is useful to give convenient gearing to the escapement, and it serves also to dismount the cylinder without displacing the frame of the wheel-work. The other end of the cylinder axis *m*, bears a pivot which works into the second plate; this axis bears the wheel of

the ratchet wheel N, which gears into the pinion *o o* of the balance.

The pinion *o*, of the balance is fixed by a pin, with the end of the axis of the balance jutting from without the rollers; this pinion bears like that of the chronometer No. 7, a pair of chops or vice *p*, which holds fast the end of the suspension spring *q*, the upper end of this spring is gripped in the vice *r*, carried by the suspension bridge O P, fastened upon the upper part of the seconds plate B B, the disposition of these vices for the spring and of the suspension bridge are the same as those of No. 7. The upper pivot *s*, of the axis of the balance, works between the three friction rollers, 7, 8, 9, and the lower pivot of the balance works between the three friction rollers, 10, 11, 12 of the frame below. In order that each pivot of the six friction rollers of the balance receive exactly the same pressure and to divide as equal as is possible the friction of these pivots, each roller is placed just midway in the length of the axis, that is to say, at an equal distance from its pivots, and in order to give this property to the rollers it has been necessary to make the axis of the three rollers of each frame of unequal length and consequently instead of simply placing the rollers in a frame as I have practiced before, the upper pivots of the roller, 7, 8, 9, are supported by the cocks 13, 14 attached to the second plate B B. The lower pivots of the rollers 10, 12, work into the cocks 15, 26. The balance QQ, is attached by two screws V V, on a plate or collet fixed to the axis of the balance *s*, *t*. When the chronometer No. 8 was finished, and I had found a spiral which had the required progression for isochronism, finding the balance too light to suit this spiral, instead of remaking another and a heavier balance I preferred to add to the circumference Q Q, of that which was made with the masses 16, 17, 18, by means of which I could succeed easily to regulate the chronometer approximately without dismounting the balance by simply rendering these masses at first heavier than the calculation given and subsequently by diminishing them little by little. In disposing these masses, I wished also to avail myself of regulating the chronometer nearly without rendering them more or less heavy which is effected by approaching or distancing them from the centre of the balance. It is for this reason that I have put a screw to the studs fixed on the circumference of the balance, but I have subsequently fixed these masses, having proved that although they are all three of the same weight, tapped with the same number of threads to the inch, and graduated into the same number of divisions, nevertheless in advancing each the same number of degrees I found that it altered the equilibrium of the balance. The lower end of the axis of the balance jutting out from beneath the rollers carries the spiral collet disposed as in No. 707, the spiral R attached on this collet is placed in the thickness of the third plate C C. The regulating pins, 28 R, are adjusted by the box 28, upon the arm *x* of the axis Y, this axis concentric with the spiral has two pivots which move in the cock TT, attached to the under side of the plate C C. The box 28 of the spiral pin, R, is fixed by a friction-tight screw on the arm *x*, so that we can by loosing the screw approach or remove this box to or from the centre of the axle according as it is wanted, and that the spiral may pass freely into the chink of the spiral regulating pins. The arm *z*, of the box of the spiral pins carries the box V fixed on this arm by a friction-tight screw; this box carries a second screw the end of which rests upon the large compensation lever X, the little arm Y of the great lever X Y, rests on the end of the two brass rods in the middle of the frame Z Z of the compensation.

The bridge T, carries a little round spring 19, the end of which acts near the axis, upon the arm 20; by this action of the spring the end of the screw of the box V rests continually on the large arm of the compensation lever, and the little arm Y on the end of the frame, so that the dilatation, or contraction of this frame is communicated to the spiral pins which follow its impressions, and lengthens or shortens the spiral as needs requires for the compensation.

To augment or diminish the range of the spiral pins, the frame of the compensation remaining the same as it should be, I have rendered the box V moveable upon its arm Z; so that whether we cause it to approach or recede from its axle, it has the effect of augmenting or diminishing the space run over by the spiral pins, and consequently renders the compensation more or less active. It suffices then for the compensation to ascertain by experiment the point where this box ought to be fixed on its arm Z, so that the chronometer does not gain or loose by heat or cold.

In order to determine what is the space passed over by the spiral pins from different degrees of temperature, its axis has an index 20, 21; the end of 21 which forms the index, marks upon the graduated limb W, the degrees passed over by the spiral pins.

The axle of the great lever X Y carries two pivots, one of which acts in the plate C C, and the other into the cock 22; this bridge

is attached by a strong screw in the plate C C; this same cock carries also the frame of the compensation Z Z, of which the cross piece 23, 23, is attached by two screws with a conical head upon the inside of the bridge 22.

(*To be continued.*)

DISTRIBUTION OF PRIZES TO THE PUPILS OF THE DRAWING CLASS.

On Friday the 9th ult. a Special Meeting of Members of the Council, was held at the Institute for the above purpose. The chair was occupied by E. D. Johnson, Esq., F.R.A.S., one of the Vice-Presidents.

Leonard Collmann, Esq., the eminent Architectural Decorative Artist, of George-street, Portman-square, kindly consented to officiate as Judge, in awarding the several degrees of merit, as follows:—

First Prize..... to Master James Haswell.
Second do...... to Master Alexander A. Klaftenberger.
Third do....... to Master Crisp.
Fourth do. .... to Master Matthey.
Fifth do. ...... to Master Clark.

Mr. Collmann stated that he considered the first and second above-named were so close in merit as to be equal. The reason he had assigned the first position to Master Haswell was, because he was the junior of his competitor; and that the whole of the drawings of the pupil's, those who were unsuccessful, as well as those who were successful, were highly creditable to them and to the Institute.

Several members of the Council expressed themselves as greatly pleased with the proficiency attained by the young gentlemen.

Votes of thanks were proposed to Mr. Collmann, for his services in making the award, and to Mr. Hoare, the late Drawing Master, which were carried and replied to.

A vote of thanks having been passed to the Chairman, by whom each Prize had been presented to the successful competitors, accompanied by appropriate remarks of an encouraging nature, was suitably acknowledged by that gentleman, and the proceedings terminated.

The Prizes were the exclusive gift of the Council, and the Prize to the Geometrical Class will be awarded in a few days.

The Drawings of the Pupils are to remain at the rooms of the Institute for a few weeks for inspection by the members.

ARTISTIC BOTANY: ITS APPLICATION TO THE LAWS OF ORNAMENTATION.

BY DR. C. DRESSER, F.L.S., F.E.B.S.

Lecturer at the South Kensington Museum, the Crystal Palace, the Polytechnic Institution, and the Metropolitan Hospitals.

Second Lecture.

Delivered for the BRITISH HOROLOGICAL INSTITUTE, *at the Parochial School Rooms, Amwell Street, Clerkenwell, on the Evening of February* 15*th*, 1861.

MR. E. D. JOHNSON, V. P., IN THE CHAIR.

(*Continued from page* 144, *vol.* iii.)

The next fact is, that it is absolutely necessary that a principle of order should exist in every composition. A very favourable illustration of such necessity has been brought before my notice since I last saw you. Her Majesty the Queen, wished for a flounce to be made of the best Honiton lace, intended to add to the charms of Princess Alice when she is married. One was prepared, which I happen to have seen, and rejected on account of the great defect, its want of a principle of order. A commission was given for a design of a most elaborate character, comprising a rose, orange-blossom, and myrtle. A very miserable representation of these flowers was strewed all over the thing. They were taken as though a person had gathered these flowers, and stuck them on various parts, just to fill up the space, without any principle of order. I confess I have great confidence in Her Majesty's taste in relation to ornamental art, I think that she leads the fashion in a wise way in these things. I was most happy to see another flounce selected, the design of which came from the Ladies' School of Art, Queen-square, at which I have the honour of teaching the principles of design. This is an illustration of the necessity for the manifestation of some principle of order in design, the want of which must always detract from that feeling of satisfaction which ever arises from the sight of true beauty. When I say that it is necessary to have a principle of

order, I do not for a moment mean to infer that it is necessary to have geometrical forms; to have a circle, a square, or anything of that kind. I may give you as an illustration of the possibility of conveying a regular principle of order—mind I am only illustrating a principle; I cannot attempt to do more; and that in a very rough, brief way—of the possibility of giving the most rigid order without absolute geometrical form. You will find it exhibited in such a diagram as this. These are the crystals of the snow when seen under the microscope. They are always constructed on the No. 3—6 principle, and are of an exquisitely beautiful character, unless the snow happens to fall in a half-thawed state, which is very commonly the case, and then a number of the parts will get mixed together, and form an irregular mass. Here, however, we have regular order, although still not absolute geometrical forms, such as the circle or square. It is indeed possible to convey the impression of a geometrical form without having it extremely rigid. That is, you may make a form by other than direct lines. Take the Indian pink as an illustration. Its leaves grow in this manner; two opposite to each other, with a little portion of the stem here. There are two more leaves growing here; but mind they ought to be roots. Of course the one of these ought to advance towards me, and the other to recede. Just let me fill this in with a flower, That is a little portion of Indian pink. Now you notice that by repeating this I have got a geometrical figure, and that I have formed it by the leaves of this plant. You may very frequently do that with great advantage, and yet not a strongly-marked geometrical figure, still having a geometrical line making the leaves answer the purpose. That is only a suggestion to show you, that while I advocate a principle of order, it is not necessary that absolutely a principle of order should be present.

The next condition which it devolves upon us to notice is the principle of adaptation to a purpose. You remark that I treated the decoration here as for carpets. The particular circumstance for which the ornamentation is required ought always to be considered. So it should be in the case of a watch. I am happy to see it acknowledged there. If you were to ask me to give an illustration among popular manufactures of the due acknowledgement of the material out of which the thing is wrought, I do not know that I could select anything better than a watch. I do not mean to say that all our watches are constructed in a beautiful manner, far from it; but still there is an acknowledgement of the material. It is all essential if we are dealing with a metal that whatever may produce it should have no sharp spikes, or anything to tear the flesh or clothes. Fancy a metal hat-stand with sharp jutting-out points. We very often hear of these absurdities in metal work. This, however, must not be the case with a watch; if it had not to go into the pocket it might be as rough as a nutmeg grater. I have seen an old-fashioned watch almost as large as a turnip that was as rough as a nutmeg grater. It ought to have something tolerably smooth at any rate. In relation to jewellery I ought to insist upon the same principle. A brooch will very often tear a lady's dress; and gentlemen very frequently realize, to their cost, that there are points about ladies' brooches. One material should never attempt to imitate another. That is a defect which is very commonly seen in our manufactures at the present day. We very frequently see jugs intended to hold liquor made of imitation wicker-work; who would ever think of going to fetch beer or water in a basket? The idea is perfectly absurd. That is just degrading art to something ridiculous; to such a pitch that it even becomes loathsome. The only thing I can say in its reprobation is that such imitations are not art at all. In the first place there should be the idea of beauty. In the second place it should be a material into which the particular material can be wrought. That is a great point to be noticed. If I am dealing with silver ware I ought to think what I can do with that metal; something which is absolutely consistent with silver. When I have found out that I have done something. I must look to something which cannot be confounded with anything else; and not try and imitate wicker-work jugs and baskets. If I wanted wicker-work I should call it so. I might throw my crockery wicker-work down, and it would break. We frequently find jugs imitating coopering. I do not want a hard crockery beer barrel, and to call it a jug. It is said that in Turkey carpets, with the materials they use, they cannot make a curved line of a very fine character. They get round as best they can, by a zig-zag line. They make a curve as best they can with the agency they employ. A friend of mine some little time ago showed me designs and asked me what I thought of them. I asked him what they were for? He replied for a Brussels carpet. A manufacturer had commissioned him to make a certain number of designs, to imitate those in a Turkey carpet, in which they cannot make curves, which in a Brussels can be got with a delicacy. We have paper imitating

weaving, with an imitation of the sketches. Now all this is perfectly absurd. When therefore you are decorating, either jewels or watches, think of what you have to do, and which cannot be done by any other process. Think of what is the most beautiful treatment of the thing you have to deal with. I find it absolutely necessary to pass over a number of things of deep interest, for the time would fail me were I to attempt to touch on them.

I must just call your attention to this fact, that although I have dealt with ornamental decorations only, yet that it is absolutely necessary, in a decorative point of view to consider the space left as well as the ornament placed there. I remember an old tutor of mine calling my attention to this fact. That was the first time the idea broke in upon my mind. He said to me, "That design is successful, because the spaces are large or small as well as the ornament." That idea had never suggested itself to me before. I had previously left the space to take care of itself, and I only took care of the ornament as well as I could; but by some sort of good luck the spaces came large or small in this instance. I have placed here a number of circles together, with spaces left between them, in a sort of diamond form. Regarding both circles as ornaments — that is, considering both the form and the ground—we may see that the ground is ornamental as well as the form. The space between those two leaves is ornamental as well as the leaves themselves. Here you see it again. You see it also in the white lily. Here you have the same in the trefoil. Here we have a number of crystals combined, having a sort of Gothic cross between them. Here is an illustration of a great number of arrangements, in which the whole ground is the same form as the space. We can apply it to more advanced and extreme figures. Here the ground is exactly the same as the form; there are a number of brown leaves as ornaments and white leaves as space. I had some illustrations of a much more complicated character, but they became so extremely difficult even to repeat, that I gave up the idea of producing them on diagrams. In all cases, however, I venture to say that where you get two alike, if it is at all complex, you cover both in order to do so; so that while I say, consider the space as well as the ornament, do not carry it to the excess to which it is carried here. It may be kept as smooth and as simple as this. This has been used with the greatest advantage, in a very simple treatment, round the Sydenham Palace. Round the exterior you see things of that kind, so that as you look through the ornament to the sky, the sky will appear of the same form as the ornament you look through.

This is a feature which I should call your attention to, but I do not think that I have a diagram here which will illustrate it. I intended to have brought you a little sketch to show you what I mean, but I have not done so. This is what we ought to consider more when the thing is to be repeated than the exact form with which we are dealing. For instance, if I take a little ornament of this kind, just consisting of four sets of leaves radiating in this way, and some little powdering, I repeat it thus. What I wish to call your attention to is this. Here the four meet at this centre, from which also they are generated. With a little care in the construction of the ornament we can make it most conspicuous. Although that centre ornament is general we can make it tell much more strongly. Sometimes it is very desirable to get these two centres, and sometimes a form on that by a geometrical figure. That is a great secret of getting a pattern to pass very easily over the wall when you do not want it to be very conspicuous. I might double the number; and directly you increase the number you decrease the attractiveness of each. There is another way in which the two centres may be considered totally distinct. Supposing I have a little radiating ornament of this kind. You notice that all these parts bear a direct relation to these centres. These two correspond; they belong to that line; they take the same range; but with a little management I can make this form a geometrical figure.

Another point is the variation of the parts. If we look at a field we shall see some large leaves and some little parts. If again we look at the stars, we see them vary, and that some are of the first, some of the second, and others of the third magnitude. Wherever we look around us we see parts of varied size.

Another point of very great interest, but which I fear my time will not allow me to enter upon fully, is proportion, which is of the utmost value in ornamental designing. If you get a geometrical figure, and divide it into two squares, for instance the proportion of 4 to 8, it will invariably be ugly. Supposing I have a shape of that kind, I would divide it into two squares. But in fact that shape I should never draw for ornament, the proportion of 4 to 8 is intolerably ugly. The proportion ought to be of a subtle character; 5 and 8 is much better and much more difficult to detect; 3 to 7 is

better. The more difficult it is for the mind to detect the proportion the more beautiful will it be. You will remember that I gave you a number of fractions last week as representing the arrangements of leaves $\frac{1}{8}$, $\frac{2}{8}$, $\frac{3}{8}$, and $\frac{5}{13}$, made from the figures 2, 3, 5, 8, 13, all bearing a beautiful relation to one another. I could carry out that idea did time permit me. I was in hopes of having ten minutes over this, but I cannot do so. A German has devoted almost a life-time to this subject, and two or three individuals in whom I have great confidence in relation to their opinion upon art having fully investigated the same, assure me that as regards the principle he is perfectly right. He gives an arrangement of this kind forgetting the best proportion. He calls it "the golden key." Here I have a horizontal line and there a vertical one. The horizontal is just twice that of the vertical. Now that, as I have said, is a very ugly proportion. Those two are connected by diagonal lines.

Thus you get a proportion of that length which is absolutely beautiful. It does not matter how you work it out.

I think you will come to the same conclusion in relation to the arches which occur in architecture. Here we see a great arch on a short pillar. The proportion here is 3 and 8. When architecture has been at its lowest ebb, when it has lost all that spirit which it ought to possess, and which it has possessed, then we find the proportion of 4 and 4. That is always a mark of decline. I could carry these illustrations out immensely further, but my time will not allow me to do so.

I have to call your attention also to the class of curves. When we talk about them we ought to have some knowledge of them. I am speaking of the line as a line, and not as a body of surface, on a space of any kind. If you take a line which bends—regarding the line, and not the figure—it will be less beautiful in the ratio of the fewness of the centres. There is a circle which has no centre. Leave out of consideration whether the circle has grandeur or not. It is agreed upon in people's minds in relation to art, that of a line which is part of a circle the most beautiful of all is the curved line. Take an ellipse; we cannot construct it with a compass. That is not beautiful, but put something in it and draw it away from the centre, with a piece of string, and you get a curve. It is more beautiful than the ellipse because it has two centres. There are two subjects with two centres, instead of one. This is an egg-shape, in which we have one end larger than the other. Here we have three centres and a curve. This is more beautiful than the last instance. It is only the most refined taste which leads to this conclusion. I simply give you the principles. Here there are four. That is struck with four centres and a curve, and is more beautiful still. I can give you one of many illustrations of the way in which the beauty of curves may be shewn. If you take a portion of string, and a piece of wood here, with a loop at one end and a hole at the other, and let it fall slack it will always fall into a beautiful line. It is all essential when studying that we should have something to refine our tastes with. If I get an instrument out of tune I cannot refine my ear by it. I can tell you as a fact of great interest in the scientific world that an invention has been brought about by which an instrument can be timed by sight more accurately than by the most refined ear. It is a Parisian discovery. The only difficulty is in applying it so that any body can do it. So fine is the adjustment that when the most refined ear has pronounced it to be in time, the philosopher can determine whether it is really exactly in time or not. We can only cultivate our ears up to a given pitch. If you hang a chain upon a nail it will produce a curve beautiful beyond conception; you may study it day after day, and after the last time of study you will come to the conclusion that no line can be more beautiful. That is a thing to refine the taste with. I could tell you of similar things, which I may perhaps hint at next week; but I can show you one other line, which is the solution of an enigma given by an individual, and for the finding of which he gave a prize. Is it possible for two lines to be for ever approaching each other, however the produce is contained, and yet never to meet? He contended that it was.

(To be continued.)

Correspondence.

To the Editor of the Horological Journal.

Sir,—The address to the subscribers to the Institute, at the commencement of the current year was deemed by some too sanguine, and was looked upon in the "Prosperity Robinson" light as a mere flourish of trumpets, but present appearances indicate that real progress is being made, and that the Institute is deemed worthy of Abuse.

Certain journals—whose unfriendly disposition has ever been manifested by the publication of anything detrimental to the

pierce the incognito of those who desire to

July 1st; the lowest was 29·826 at noon of

the 5th. Hence the greatest range was about ·883 of an inch.

The average July temperature, as deduced from the Greenwich records, is 62°; and the temperature of the past month has been about the mean.

Rain fell on 20 days. A rain guage at Camden Town,* 100 feet above the sea-level, collected 2·53 inches during the month; which is a little less than the average fall for July. The heaviest fall was on the 27th, when $\frac{4}{10}$ of an inch was collected.

The winds of July have been strong, but not violent, and the SW wind has been remarkabiy prevalent. Referring the wind observations at 9 a.m. to the cardinal points, we find that it has been N on five days, S on 14 days, W on 12 days. No wind storm of a destructive nature has occured; but several violent thunder storms accompanied with heavy rain, and occasioning damage in some parts of the country, have happened. Such storms are common to the summer months. The table gives the day of their occurence, and as I have not observed anything peculiar connected with them, no additional instrumental observations appear to be necessary here. R.S.

St. Swithin's Day.—The value to be placed upon the popular notion that if it rains upon the 15th of July it will do so for the 40 succeeding days may be learnt from the following facts, from the Greenwich observations for the last 20 years. It appears that St. Swithin's Day was wet in 1841, and there were 23 rainy days up to the 24th of August; 1845, 26 rainy days; 1851, 13 rainy days; 1853, 18 rainy days; 1854, 16 rainy days; and in 1856, 14 rainy days. In 1842 and the following years St. Swithin's day was dry, and the result was in 1842, 12 rainy days; 1843, 22 rainy days; 1844, 20 rainy days; 1846, 21 rainy days; 1847, 17 rainy days; 1848, 31 rainy days; 1849, 20 rainy days; 1850, 17 rainy days; 1852, 19 rainy days; 1855, 18 rainy days; 1857, 14 rainy days; 1858, 14 rainy days; 1859, 13 rainy days; and in 1860, 29 rainy days. These figures show the superstition to be founded on a fallacy, as the average of 20 years proves rain to have fallen upon the largest number of days when St. Swithin's day was dry.

* G. J. Symons Esq., Observer.

British Horological Institute.

NEW MEMBERS.

The following Gentlemen have been admitted as Members of the British Horological Institute during the past month:—

Mr. Henry Moore; Daniel Todd; — Funnell; Cox & Co.

EQUATION OF TIME TABLE

For September 1861.

Difference for One Hour	At Apparent Noon. Equation of Time to be added to Apparent Time.
s.	m. s.
0·787	0 11·70
0·798	0 30·59
0·808	0 49·73
0·818	1 9·12
0·827	1 28·77
0·836	1 48·63
0·845	2 8·70
0·852	2 28·98
0·858	2 49·43
0·864	3 10·04
0·870	3 30·79
0·874	3 51·68
0·878	4 12·67
0·881	4 33·76
0·883	4 54·91
0·884	5 16·10
0·884	5 37·31
0·882	5 58·53
0·880	6 19·72
0·877	6 40·85
0·874	7 1·92
0·869	7 22·90
0·863	7 43·76
0·856	8 4·47
0·848	8 25·01
0·839	8 45·37
0·830	9 5·51
0·819	9 25·42
0·808	9 45·09
0·796	10 4·46

TO CORRESPONDENTS, &c.

All Communications for this Journal should be addressed to the Editor, *before the 25th, at the Office,* 35, Northampton Square, Clerkenwell.

N.B.—All Advertisements to be inserted in the Journal must be forwarded to W. Hislop, Honorary Secretary, at the Office 35, Northampton Square, E.C. before the 23d of the Month.

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TOWN AND COUNTRY.

BRITISH HOROLOGICAL INSTITUTE.

THE MUSEUM.

The want of a collection of tools, specimens of work, models, and drawings, illustrative of practical horology, is much felt by every earnest student of the science. There are few persons, however advanced in knowledge or experienced in practice, who may not learn something from others. Much useless labour may be saved by knowing what others have already done, by suggestions developing a previously existing idea, or by the impartation of some means of arriving at our results by a simpler, more economical, or readier method. Nothing can contribute so much to this end, as a *practical museum*, by which we mean, not so much a collection of specimens of antiquity or objects of curiosity, as of articles imparting information, by the illustration of processes, the developing of certain modes of action, or means of facilitating manipulation. There are many private collections, more or less bearing on the subject, and most of us have been in the habit of putting together objects of interest. But it is especially in a public museum that we must look for the great value of such collections, for it is to such that all may contribute, and each may by contributing be the gainer either in knowledge or fame. When the British Horological Institute was founded this was felt to be a most important point, and although it is generally a tedious task to form such a collection under the peculiar circumstances in which we are placed, yet the work has progressed steadily.

We have to record several recent accessions. One of great importance, as showing the interest taken in our object by the Board of Admiralty, is the presentation by that body of a second specimen of chronometry. It is a Marine Chronometer by Earnshaw, No. 364, and may be regarded as an earnest of future gifts; especially when we know that Professor Airy, under whose superintendence the chronometers of the British government are placed, has expressed in a recent letter to the Honorary Secretary, acknowledging his election as an honorary member of the Institute, opinions which are most flattering and encouraging to its well wishers.

There has also been presented by Mr. John Bennett, a Japanese clock, curious as being a miniature copy of De Vic's old movement of 1364. We have one of Payne's Pedometers, and a Gowland's Spherical Compass, presented by Mr. E. D. Johnson. A most exquisite specimen of Mudge's Marine Chronometer with his remontoir escapement, purchased by the Council. An Escapement of Emery's, presented by Mr. Blackie, and the Pendulum Spring Gauge by Mr. Styles, described in the present number, with two Duplex Wheel Swing Tools, and a Gauge for Testing the Strength of Pendulum Spring Wire, by Mr. Mylne.

It would be of considerable advantage if a collection of specimens illustrative of each branch could be brought together. For instance, take watch jewelling:—how many finishers, escapement makers, or manufacturers, know anything of the peculiar processes of watch jewelling? But if the tools used, and the materials in their various stages, could be brought together, a great deal of information could be obtained at a glance. There are also many tools in the possession of some escapement makers, the existence of which is unknown to many, but which might suggest important improvements if capable of access to those more immediately concerned. We are empowered to state, that to render the collection more extensively available, it is the intention of the Museum Committee, to

publish occasional descriptions of the more interesting and useful specimens which may be committed to their charge.

One subject to which the attention of the Committee has been directed, is that of a Standard Horological Gauge. Some little time since, with the consent of the Council, they sent out a circular calling the attention of the Trade and others to the matter. Numerous responses to that appeal have been made, and various specimens, both from home and abroad, have been contributed either in the form of the gauges themselves, models, or drawings. Sufficient material has in fact come to hand, to furnish subject for thought and developement; and they are therefore now engaged in drawing up their First Paper or Report, in which they propose to embody descriptions and details of the methods of measuring which have thus come under their notice. Very soon after the issue of the circular, amongst others, M. Grossmann, of Glashütte in Saxony, forwarded a valuable paper descriptive of the system of measurement adopted there, accompanied by drawings of their gauges. This has just been followed by a present, on the part of that gentleman, to the Museum of two most beautifully constructed instruments. Mr. Roberts, C.E., of Manchester, has also confided to our charge three gauges, one of which is the Eccentric Gauge, the fundamental principle of which will, probably, be found of great value, as being applicable in a variety of ways. Connected collaterally with the primary object of the Gauge Committee, the subject of Angular Gauges, or tools for measuring angles, has been brought before them, and a New Lever Escapement Sector by Mr. Tillins has been submitted to them, a notice of which has been published at once, as touching upon a question of the greatest importance in the constructive improvement of escapements.

Since the above was in type, we have been favoured by an inspection of another beautifully-executed Gauge for similar purposes, by Mr. J. F. Cole. We hope to be able to get the necessary engravings executed in time for insertion, with that gentleman's own description, in the next number of the Journal. In the meanwhile, we may state that the instrument is intended to measure the angle of the pallet plane, and being then clamped, it gives the distance and size required.

W. HISLOP, Chairman,
Museum and Gauge Committee.

BERTHOUD'S DESCRIPTION OF HIS MARINE TIME-KEEPER, No. 8.

TRANSLATED FROM HIS "TRAITE DES HOROLOGES MARINES."

Paris, 1773. *Chap.* x. *page* 271.

(*Continued from page* 9.)

Plate XVIII. (*Fig.* 2.)

Plan of the Chronometer, No. 8.

I have disposed in this Plan of the Chronometer, all that belongs to the movement, wheelwork, pillars, bridges, rollers, even to the position of the holes for the pillar, feet, pivots, &c. made in the plates.

By this means, a plan well distributed, facilitates much the execution of a machine, for it is by its aid alone it is possible in some way to imitate a complex machine.

A, is the opening made in the dial-plate to see the hours engraved on the hour-dial, borne by the first wheel; *a*, the index borne by the plate to indicate the hour. B, is a portion of the eccentric minute dial to the large dial; C, is a portion of the dial for the seconds concentric with the large dial; D, is the large wheel of the circular plate of the hours, this wheel has 240 teeth; E, is the ratchet of the auxiliary spring, it has 150 teeth; F, the ratchet of the click, it has 100 teeth; G, is the size of the cylinder or barrel, the line *b*, *c*, represents the cords of the weights, which passes over the direction pulley, *c*, *d*, supported by the two little

Fig. 1. *Plate XIX.*

Fig. 2.

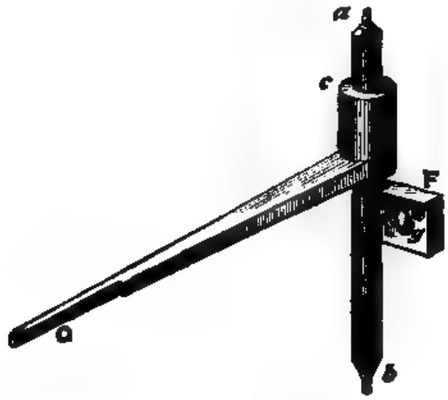
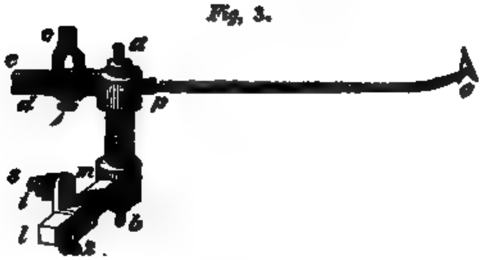


Fig. 3.



bridges, 1, 2. The large wheel of the barrel D gears into the minute pinion *e*; the circle B, represents the minute wheel, it has 160 teeth; and the pinion *e* has 20.

The wheel B gears or drives the pinion *f* of 20; this pinion bears the little or middle wheel, H of 150; this wheel gears into the pinion *g* of 20, which is that of the seconds; it bears the escapement wheel I of 30 teeth; which acts on the cylinder *h*, with ruby pallets; the axis of which bears the ratchet wheel L, which gears into the pinion of the balance *l*.

M, N, O, are the friction rollers of the balance; and *m*, *n*, *o*, their bridges; the bridge *m*, of the roller M, is fastened by two screws, because its feet have a play, in order to be able to remove them from or make them approach to the centre of the balance, to take away or give play to the pivots of the balance between the rollers.

P *l*, is the suspension bridge of the balance.

P, P, P, are the pillars of the little roller frames; Q, Q, Q, the three large pillars of the second frame of the regulator or balance; R, R, R, R, the four pillars of the first frame, which is that of the wheel-work; S, S, S, the three pillars of the third frame, which is that of the weights.

The little circle *q*, indicates the true position where the end of the cord of the weights ought to be hooked, so that the lines may be parallel to the weight in the centre of the frame, and may descend freely without friction against the pillars; the point *d*, is that through which the cord descends.

The holes or little circles, *r*, *r*, *r*, mark the position of the feet, pierced in all the large plates to adjust the caliper or plan above, and pierce the plates for the parts of the chronometer in their true position.

The little circles, *s*, *s*, *s*, indicate likewise the position for the feet, pierced through the large and small plates, for the holes of the rollers. T is the click, which keeps back the auxiliary ratchet, in order that the spring which this ratchet bends may keep the chronometer going while it is being wound.

The circles V, V, represent the site of the balance; the exterior line marks at the same time the size of the balance and the size of the little roller plates; the little plates for rollers, D, D, (*fig.* 1), have been diminished for the passage of the weights or masses of the balance.

Plate XIX. (*Fig.* 2.)

Mechanism of the Compensation.

The figure 1 shows the plan of the mechanism of the compensation under the third plate; A, A, is the under side of the third large plate, which I call the compensation plate; *a*, *a*, *a*, are the holes for the pillars of the frame of the weights; *b*, *c*, *d*, are the bridges of the rollers, these bridges carry the steel plates; *e*, *e*, *e*, or small bars to receive the ends of the pivots of the rollers, and to avoid the friction of these pivots; the bridge *b*, bears two friction-tight screws to serve to fix this bridge solidly when one has given a convenient play to the axle of the balance between the friction rollers.

The large bridge B, carries the frame of the compensation by means of the cross-piece D of this frame which is fixed by two screws against the upright of the bridge.

The bridge B, D, serves at the same time to support, while rolling on its two pivots, the large compensation lever E, moveable in *f* (as seen in perspective, *fig.* 2); the little arm F of this lever carries a steel pin, terminating in a cap, *g*, which leans against a piece, also of tempered steel, and borne by the extremity of the brass rods, from the middle of the compensation frame C, D. By this disposition, although the rods have a little play, their action on the lever or arm F, is continually acting at the same distance from the centre *f*.

The end G, of the great lever E, G, (*fig.* 1), is ready to act on the screw of the box *i*, borne by the arm *l*, of the curb pins *H*, *i*, *l*, (see these spiral curb pins, in perspective *fig.* 3); by this means the dilatation or contraction of the compensation frame makes the curb pin H turn about the centre of the spiral I, L, and elongates or shortens the spring the requisite quantity for the compensation.

The little bar *m* (*fig.* 1), borne by the bridge M of the curb pins, carries a straight spring which acts by pressure against a knob near the centre of motion of the mechanism for altering the place of the curb pins, and compels the end of the screw *i* to bear against the end of the great lever, and consequently force the arm F of this lever to press continually against the end of the frame and follow its motions.

P is the arm of the index O, which marks on the graduated limb N, the space or path traversed by the spiral curb pins.

The exterior end, L, of the spiral is fixed by a pin *n*, to a moveable stud O, which is fixed upon the plate by a screw, when the spiral has taken its free position.

The spiral is placed in an aperture in the thickness of the plate, A, A, in order that it be right against the friction rollers, and that the action may have less effect on these rollers; since the plate being thus pierced, we cannot make the mechanism of the curb pins work in the plate itself. It is for this reason, that P and M form a double bridge or frame for the upper and lower pivots of the mechanism of the (see *fig.* 3, Plate xix.), curb pins; the bridge, P, fixed to the plate by the screw 1, with steady pins, receives the pivot of the spiral curb pins at the side of the plate; and the bridge M, attached on the former bridge P by the screw 2, and two steady pins, bears the other pivot of the mechanism.

The bridge B of the large lever E, F, G, bears at its extremity a plate, D, attached by the screw 3, on the end of the bridge B, this plate held by strong steady pins serves to bear the hole *f* of the pivot of the great lever; and by removing this plate, one can dismount the lever without dismounting the frame or the bridge which supports it.

The screw 4 fixes the bridge B on the plate A, A, by means of two strong feet, it being essential to render all this part of the compensation perfectly immoveable.

The dotted circles Q, Q, Q, mark the situation of the friction rollers, and their intersections; it is between these rollers that the axis of the balance passes through the aperture made in the plate for the spiral.

R, R, R, are the ends of the pivots for the pillars of the little frame of the friction rollers.

The *fig.* 2, represents in perspective the large lever of the compensation; *a*, is the pivot which works in the plate, and *b* that which works in the plate of the large bridge of the frame; F is the little arm formed of the same piece as the axle; *g* is the pin terminated in a kind of knob or cap to bear against the projecting end of the rods at the middle of the frame; this pin enters in a hole made like a pallet or arm, F, and is rivetted to it; G is the great lever, the tempered steel end of which acts upon the screw of the mechanism for giving motion to the curb pins; the cannon or cylinder, *c*, of this lever, is forcibly thrust upon the arbor or axle *a*.

It is very essential that the friction of this pipe upon the arbor should be very strong, so that they cannot turn separately the one without the other.

Fig. 3 represents the mechanism of the curb pins, seen in perspective; the pivot *a*, works in the lower bridge P (*fig.* 1), and that of *b* in the bridge M; *c* shows the curb pins, the box *d* of which moves upon the arm *e*,

being fixed thereon by the screw *i*; the box *i* likewise moves upon the arm *l*, and is fixed thereon by the screw 2, this box carries the screw 3, the end *m* of which, serves to bear against the great lever of compensation; it is this screw which is thrust (friction tight) upon its box that is employed for regulating the watch approximately. It has been shewn in 853, that this box *i* is moveable upon the arm *l*, in order to find promptly the point of compensation; *p*, *o*, is the arm of the index itself, which marks upon the limb N (*fig.* 1), the amount of the motion of the curb pins, when the watch has undergone a change of temperature.

Of the Collet and Stud of the Spiral.

We have seen in the first part, in treating of the spiral, how essential it is that its two ends be solidly fixed, and that nevertheless the spiral should be in a perfectly free state and not strained. To accomplish this end, in my first marine chronometer, it has been seen that the inner end is held by two screws in a kind of vice, of the same curve as the spiral. These chops are brought together by means of two screws; the inner end was also in like manner clipt by the same means; the large dimensions of this chronometer had rendered it easy to obtain this excellent construction. The chronometer which I made subsequently, not being so large nor the spiral spring so strong, I thought that it would suffice to pin them in like we do those of watches by the pressure of the pin. I was soon obliged to abandon this practice, very good for watches, but was worth nothing for marine chronometers; all the difficulty was to apply the same construction to the marine chronometers, and it is what I have happily accomplished for No. 8, and in a simple manner, but there remains still a perfection to be given to the spiral stud.

I had observed, that however trifling the deviation might be of the spiral from a straight line, yet, that on pinning in the exterior end of the spiral, one of the ends or sides of the spiral pin became elevated or depressed, so that in pinning in, the spring was strained, and the oscillations were in consequence less free. I had removed this difficulty by filing away the under side of the pin sufficiently, so that the under part of the latter should bear flat, when the length of the spiral should have been ascertained; but this operation was never so exact as I desired it to be, and it was necessary in order to determine it by a number of trials which I did not like. To ward off this defect, I attached four screws to the basis of the stud, which served to level it, this I found to succeed very well.

One can see the pin and collet of the spiral, Plate xx, *fig*. 587, and their description at the end of chap. xiii., describing chronometer No. 10.

Exact Dimensions of all the Parts of the Marine Chronometer, No. 8.

Elevation of the Chronometer all collected:—

	French Inches.	French Lines.	English Inches.
The total height of all the frames over the dial plate	13	10	14·75
Steel pillars of the frame of weights . . .	10	6	11·20
Height of the bridges of the plate of weights . .	2	5	2·58
Descent of the weights .	8	0	8·54
Size of the steel pillars .		6	0·53
Pivots . . .		4	0·35
The pulleys of the weights (in diameter) . .		15	1·33
Pivots (in diameter) .		$\frac{18}{48}$	·033
Thickness of the plate bearing the steel pillars .		$1\frac{1}{2}$	·133
Plate of the weights . .		1	·089
Large frame of the regulator (pillars in height) .		21	1·87
Small frame of the regulator (pillars in height) .		15	1·33
Height of the suspension bridge of the balance, measuring from underneath, comprising the little cock . . .		23	2·04
Frame of the movement .		13	1·55
Thickness of the dial plate .		$1\frac{1}{2}$	·133
The diameter . .	6	$6\frac{1}{2}$	6·96
The others . . .	6	6	6·84

Mechanism of the Compensation.

	French Inches.	French Lines.	English Inches.
Height of the bridge of the large lever, taken from underneath . . .	2	$5\frac{1}{2}$	2·62
Size of the cross bar of the frame . . .		28	2·49
Length of the frame outside	6	4	7·3
Thickness of the rods (16 rods in number) . .		$1\frac{4}{12}$	·118
Large lever of the compensation point of contact .		30	2·67
Pivots		$\frac{9}{12}$	·067
Little arm of the large lever from the centre . .		$2\frac{11}{12}$	·26
Thickness of the staff .		$2\frac{1}{2}$	·222
Little lever of the compensation is concentric to the balance, the arm which communicates to the large lever carries a box in which the tangent screw is distant from its centre .		$2\frac{1}{2}$	·222

	French Inches. Lines.	English Inches.
Height of the axle of the little lever . .	11	·976
Distance of the curb pins to the centre of the axle .	$4\frac{1}{2}$	·355
Pivots . . .	$\frac{7}{12}$	

Dimensions of the Spiral Stud.

	French Inches. Lines.	English Inches.
This stud is of brass; but it ought to be of tempered steel, like those of No. 6 and 7, by reason that the spiral having its turns very close, it leaves but little thickness at the end of the chops or vice.		
The foot ought to be this size	$6\frac{1}{2}$	·577
Length, not comprising the vice (machoire) . .	9	·8
Length of the machoire .	2	·178
The height ought to be proportioned to the breadth of the spiral, which is 3 lines.		
A spiral of $2\frac{1}{2}$ lines would be better.		
Then the machoire will have in height about 4 lines.		
Thickness . . .	$2\frac{1}{2}$	
The mortise has . .	$1\frac{1}{2}$	
The four screws borne by the foot, to keep it level so that the spiral does not warp, are of brass, so that it does not mark the plate, and are tapped in the screw plate No. 10 of the above as aforesaid		
The spiral is marked No. 15, its breadth $1\frac{7}{12}$ lines (ought to be $2\frac{1}{2}$ lines for size), length in all 11 inches, it acts only about $9\frac{1}{2}$ inches having 18 lines from the spiral pins to the end, its weight 25 grains, the point where it is pinned in at the stud makes $7\frac{1}{2}$ turns, at this point its dimeter is $8\frac{1}{2}$ lines.		
The distance of the point where the spiral is fixed to the stud from that where the curb pins act is $5\frac{1}{2}$ lines or nearly 80 degrees.		
Thickness of spiral . .	$\frac{5}{48}$	

Movement, or Wheel-work.

	French Inches. Lines.	English Inches.
Large wheel of the cylinder 240 teeth, diameter . .	$36\frac{1}{2}$	3·25
Thickness . . .	$\frac{10}{12}$	
Thickness of the ratchet of the auxiliary spring . .	$\frac{8}{12}$	
Diameter (has 150 teeth) .	$33\frac{1}{2}$	2·97
Auxiliary spring, same diameter as the ratchet of the click.		
Thickness . . .	$\frac{13}{12}$	
Breadth . . .	$1\frac{1}{2}$	
Ratchet of the click .	28	2·49
Thickness (has 100 teeth) .	$\frac{10}{12}$	
Diameter of the cylinder without the grooves . .	$23\frac{1}{2}$	2·04
Height without comprising the edge, contains three turns of the cord . .	3	
Size of the steel arbor at the small end . .	$1\frac{9}{12}$	
Size of the cannon on which is adjusted the cylinder .	$2\frac{7}{12}$	·155
Size of the pivot at the side of the square of the remontoire . . .	$1\frac{6}{12}$	·133
The other pivot . .	$1\frac{4}{12}$	·118
Size of the socket on which is adjusted the hour dial .	3	
The minute wheel (has 160 teeth) . . .	$19\frac{4}{12}$	1·72
The thickness . . .	$\frac{4}{12}$	
Its pinion (20 leaves) .		
The pivot which bears the minute hand . .	$\frac{18}{48}$	
The other pivot . .	$\frac{16}{48}$	
Little middle wheel in diameter (has 150 teeth) .	18	
Thickness . . .	$\frac{4}{12}$	
Its pinion . . .	20	
Its pivot . . .	$\frac{13}{48}$	
Steel escapement wheel diameter (has 30 teeth) .	18	
Thickness . . .	$\frac{4}{12}$	
The pivot carrying the hand of the seconds . .	$\frac{3}{48}$	
The other pivot . .	$\frac{11}{48}$	
The balance wheel, 160.		
Arc of the escapement, 20 degrees.		
Balance, 80 degrees.		
Thickness of the wheel .	$\frac{4}{12}$	
Its pivots . . .	$\frac{8}{48}$	
Exterior diameter of the escapement cylinder . .	$2\frac{11}{12}$	

Regulator.

	French Inches. Lines.	English Inches.
The balance (diameter of) .	$55\frac{7}{12}$	4·94
Thickness . . .	$1\frac{11}{12}$	

	French Inch. Lines.	English Inches.
Breadth of the rim of the balance	$2\frac{5}{12}$	
Breadth of the centre or ball of the balance	8	·712
Thickness	$1\frac{1}{12}$	
Breadth of the cross pieces at the extremity	$2\frac{1}{12}$	·185
Weight of the balance 3 oz. $1\frac{1}{2}$ gros. 27 grains=1037 troy grains.		

Axle of the Balance.

	French Inch. Lines.	English Inches.
Diameter of the plate which carries the balance	$6\frac{10}{12}$	·6
Size of the plate for the jewel holes of the balance	$2\frac{4}{12}$	
Size of the axle	$1\frac{1}{2}$	
Pivots	$\frac{11}{12}$	·124

Rollers.

	French Inches. Lines.	English Inches.
The three friction rollers (diameter of)	$28\frac{1}{2}$	2·53
Each roller mounted on its axis finished and polished weighs 3 gros. 18 grains = 192 troy grains.		
Height of the pillars for the frame of the rollers	$4\frac{1}{2}$	

Note.—In the plan that I have given of this Chronometer, the balance wheel is traced very small, so that it passes at the side of the arbor of the seconds wheel, and prevents the necessity of a cock which one must have been employed as in No. 8, to let it pass underneath the arbor of the balance wheel.

ARTISTIC BOTANY: ITS APPLICATION TO THE LAWS OF ORNAMENTATION.

By Dr. C. Dresser, F.L.S., F.E.B.S.

Lecturer at the South Kensington Museum, the Crystal Palace, the Polytechnic Institution, and the Metropolitan Hospitals.

Second Lecture.

Delivered for the British Horological Institute, *at the Parochial School Rooms, Amwell Street, Clerkenwell, on the Evening of February 15th,* 1861.

Mr. E. D. Johnson, V. P., in the Chair.

(*Concluded from page* 12.)

This is the solution of the enigma. Of course you may guess that there is extreme subtlety in a thing of this kind, which is more a delusion than any thing else. It is a sort of cheat. This is a horizontal line of given quantity, it does not matter what. We divide that into equal distances and this is the effect. We divide that again into half the distance, say six inches, then half that again, three inches; then half again, one and a half inches. It does not matter how long you may go on there must be some distance remaining. This line touches this apex, and is very beautiful.

Inasmuch as a plant never developes itself upwards and downwards—that is it has not stems down in the ground as well as above—so in ornamental decoration, they should never be represented both ways. To my mind the representation of a plant growing both ways is the perfection of ugliness. In nature it is an impossibility. Here it has two distinct leaves but that is another matter all together.

What we ought to regard in ornamentation is the relation of the form to the object made. Every thing we do in ornamentation ought to bear the most critical inspection in this respect. If we fully considered in all cases the circumstances of the article before we designed it, it would convey all the thoughts and results which we had arrived at. The German Professor Semper says, that it is only necessary for us to have the water vessels of any nation to discover its history to a great extent. You may think that statement is rather stretching the point, but there is some truth in it. I do not pretend to say that one of our wicker-work jugs would convey any fair idea of the history of our nation. To show how far some of the nations of antiquity have surpassed us in considering these matters I may take as illustrations two water vessels. Here is a Greek one and there is an Egyptian specimen. How much can we learn of the respective histories of those people from those vessels? Let us examine their cases. The handle of the one is made under-hand, and to hang from the hand. The Egyptians, as you known, had to fetch their water from the river Nile. The bank being above the water the person fetching it was obliged to tie a string to the vessel, and to throw it

into the river. Now we can see why it was made in a shape which would not enable it to stand. If it had been made like a washing tub it would have floated down the stream. This form was very convenient to carry, and it enabled the person to conduct the mouth to the water, and prevent it from slipping over. Our pails on the contrary, are widest at the top, and it becomes necessary to put in a board that it may not slip over. Here again you see the shape of the Greek water vessel, which is not at all like the other. It stands very easily. In this case the mouth is to be conducted in a manner altogether different from the other. How did the Greeks get their water? From the drippings of the rocks. It is shaped so as to collect as much water as possible from the rocks. Here is a vessel of great capacity; but it is wider at the top than at the bottom. The people were accustomed to carry them on their heads. When the weight is at the bottom, as it would be in this form, you can balance it with the greatest ease. See how much instruction is conveyed in the simple form of a water vessel. How nicely both people considered the circumstances of their country in the formation of these vessels. Our water vessels would convey to posterity very little notion of the way in which we get water from our wells, either by the top or any part of them. I do not say that they were limited to that form exactly.

Extravagance is as loathsome in ornamentation as it is in any thing else. Thousands who have visited St. James's Hall, will remember that the great arch which spans the orchestra is perfectly plain. By its contrast with the more richly decorated parts it adds immensely to the beauty of the building.

The mode of treatment of the object, as I have before intimated is an important point for consideration. It should be purely natural, such as is represented in these diagrams. The early development of the elder with the buds bursting in spring will make no bad Gothic hanging for a church door. That is one mode of getting forms from nature, and applying them to the purposes of ornamentation. That is always a great point in art. Here is taste and beauty limned in it. That is only a developement, and not an original plan. Ingenuity is displayed in the application, and that is all. That is borrowed. The next treatment is taking a sort of idea from nature, catching its spirit, and embodying it in a new form, of which these diagrams are illustrations. These are by no means copies of the buds which burst in spring, although it is founded on it. That is the next advance. The last advance is the purely conventional; the purely mental production, which perhaps is the highest form of art. The more the mind loses example, and gets wisdom from the teaching of nature, and then rises to the exalted position which man is called to rise to of producing like beauty with nature, that is the highest form of art.

PENDULUM SPRING GAUGE.

The following letter, accompanying a specimen of the tool therein described, has been recently laid before the Council of the Institute. We have great pleasure in inserting it, together with a woodcut of the instrument, for the information of our readers.—Ed. H. J.

To the Council of the Horological Institute.

148, Central Street, King Square, E.C.

Gentlemen, — I herewith beg of your acceptance of one of my Pendulum Spring Gauges, to be placed in the Museum of the Institute.

In so doing, allow me to state the object for which it is intended. It is to introduce into the trade a more improved method of springing lever watches. Any finisher knows that there is not any difficulty in getting a good spring, but he is also aware there is no dependence to be placed in the wire, and there is therefore, frequently a great deal of time lost in applying the spring to the watch.

Again it is well-known that the finisher frequently plants the spring too large or too small.

It is, therefore, to remedy these defects that I have brought this tool before your notice, and in so doing I have paid a great deal of attention to its construction. I have commenced supplying to the Trade balances and springs so adjusted to each other as to perform correctly. But in order to carry out my plan it is necessary that the finisher should plant the spring correctly as to size and centre. The small tool of which I beg your acceptance is calculated to enable him to do so, and at the same time it will plant the spring circular. It will plant a spring from four to a twenty-size movement. The balance will be half the size of the upper plate.

I find that movements of the present manufacture do not increase regularly in size; my gauge being made to suit them is not a regular one, but adapted for the present style of movements.

To use it, place the point of the cylinder in the hole of upper plate for spring under watches, and in the hole in the cock for

those that are sprung above; then I bring the plate down to the cock or upper plate, and you will at once get the size to mark the index, then turn it round to the stud and there is the circle marked for the pin hole. I am Gentlemen, your's obediently,

SAMUEL STYLES.

Fig. 1.

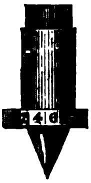


Fig. 2.

Fig. 1 is a side view and *fig.* 2 an end view of the tool described above. It consists, as will be seen, of a plug or centre on which slides spring tight a piece of brass, shaped very like the hour snail of a striking clock. On each step of the snail is engraved a number indicating the size of the movement for which that particular step is to be considered as indicating the diameter of the outer coil of the pendulum spring. The Tool itself may be seen in the Museum of the Institute.

TILLING'S LEVER ESCAPEMENT SECTOR.

The difficulty of defining the proportions of the various parts of a lever escapement in relation to the balance arc, arising from the complicated nature of its principle, has always been felt by escapement makers.

Hitherto the practice has been to make them to gauges, or measurement of diameter and length of the parts, without determining the points of action in accordance with the angle of the pallet, the result is, escapements made apparently alike will vary considerably in the measurement of angle at the balance.

Observing those variations, led me to devise an instrument that could be adjusted to give the proportion correct to any length of leverage, or pallets of any degree of angle. The power not being exerted direct on the balance in the lever escapement as in the chronometer and other escapements, but through an intervening mechanism of plane and leverage, rule or simple measurement is useless.

A fixed result is required from the ever-varying effect of angle and depth dependent on the workmen, whose opinions are seldom alike, showing the necessity of such an instrument as the Lever Escapement Sector, which defines the whole principle of the escapement by simple mechanical motion, giving the size of the roller, with the position of the impulse pin, length of lever, and roller depth, with the position of the pivot holes, and indicating the balance arc of an escapement from size No. 1 to a large clock, whether made with pallets of 7, 8, 10, 12, or 15 degrees of angle.

J. L. TILLING.

1, Elizabeth Terrace, Liverpool Road.

The above paper is accompanied by a card model and description. From the difficulty of making a drawing of and engraving from such a model, the Gauge Committee, to whom the communication has been sent, have thought it best to defer the publication of precise details until they have the opportunity of engraving from the instrument itself. In the meanwhile, as it is intended for publication, the Chairman of that Committee will be happy to shew the model to any member of the Institute.

It may suffice for the present to state, that the tool something resembles an ordinary wheel and pinion sector. There is a base plate of brass, upon which a radial arm moves to and fro over certain scales of divisions drawn in different positions for the various measures to be obtained. A hollow cylinder, containing a point for marking, projects over this arm towards its centre of motion at a part where a sink is made for the reception of the roller when turned to the size indicated by another part of the gauge. The arm is first set to the number marking the size of the movement, on a scale representing a certain balance arc of escapement, say 36 degrees with 12 degee pallets. The roller is turned to the size indicated, flatted also according to measure, put in its place on the sector, and then marked for the pin. Another part of the sector then gives the lever and roller depth.

In the next number of the Journal, the Committee hope to furnish an engraving and detailed description.

W. H.

HOROLOGICAL SCIENCE.

We are gratified in finding that the Horologists of this country are already moving in regard to the Great Exhibition of next year. We have felt it our duty towards this important section of manufacturers to point out from time to time—with the best possible motives—the weaknesses and failings which appear to have militated against its advance toward that high position which some other branches of mechanical workers have succeeded in achieving. It is not for the purpose of reproducing arguments and facts previously employed that we now touch upon the question of horological science. The leading members and supporters of the Watch and Clock Trades of Great Britain can-

not but be painfully aware that their position is a precarious one. They are brought into direct competition in the market with the results of American automatic machinery and of the cheap female labour of Switzerland, and it can scarcely be denied that they are losing ground.

In the forthcoming display of the industrial, artistic, and mechanical ability of the people of England it is especially desirable, however, that no shortcoming should be visible. We are anxious that so far as the mechanical arts extend, at any rate there shall be no possibility of comparisons being instituted disparaging to the industrious classes of this country. The skilled English workman has hitherto—in all that pertains to the engineering and kindred trades—borne away the palm from all competitors; and we are of opinion that with organization and co-operation on the part of horologists, they also will avoid the disgrace of being outdone in those great national competitive examinations which hereafter may be looked upon as of decennial occurrence. That the Council of the Horological Institute have caused circulars to be issued, inviting contributions to the horological department of the new Exhibition, we are aware, and we give that body all due credit for the fact; but if a really successful domonstration of the talent of British horologists is to be made, it must be by the whole body combining together in harmonious concert, and acting with a determination not to be beaten. There are among them, undoubtedly, men whose knowledge of the scientific rules, and whose skill in the practical branches of horology, are not excelled by any handicraftsmen in the world. Let this fact be made patent, then, at the new Exhibition, and let our clever horologists lose no time in closing up such crevices in their armour as the experience of the last few years have shown them to exist.

We believe that the time will come when machinery *must* be introduced into English horology. There is no reason at all why the hand labour of English workmen, admirable and unrivelled as it is, should be subject to the disadvantage of contending unaided against the machine-made clocks and watches of America. In another part of this Journal of to-day's date, there appears a description of the beautiful machinery at Enfield, for manufacturing weapons of destruction, and we see no reason whatever against the introduction of machinery on the same principle, for the manipulation of the various parts of time-keepers.

It is only by keeping pace with the march of improvement, if not leading the van in it, that horologists may hope to save themselves, as a body, from decay or dissolution. While they preserve intact, therefore, their own great constructive talent, which goes to make the English chronometer the best time-measurer in the world, they should arm themselves with those other means which machanical appliances confer, for competing with the cheap manufactures of America, which answer many of the ordinary purposes of life, and must, in numerous instances, stand in the stead of more expensive productions.—*Mechanic's Magazine.*

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

(*Continued from page* 128, vol. iii.)

1845, September 25.—No. 10,838.

BAIN ALEXANDER.—1. Relates to electric telegraphs.

2. Relates to electric clocks. Two brass brackets are screwed to the back of the case, and bear a hard-wood bar, which lays between the two upright parts of a bracket. Fixed on one end of this bar is another piece of hard wood, in which is inserted a piece of gold, the surface of which is made concave longitudinally, and on the surface of the cavity lies the gold soldered point of a steel bar. At this end the gold is always in contact. The other end of the steel bar is also gold soldered, and when it is in contact with a gold pin inserted in a piece of stone or agate, the circuit is complete. There is a "knee'd piece of brass" screwed to the pendulum rod, and there are two cylinders containing reels of copper wire covered with silk and screwed to the bracket below. The machine works as follows:—When the circuit is complete, the electric current passes by the conducting wire to the left-hand reel, from thence to the right-hand reel, thence to the gold in the wood, thence, by the gold points of the steel bar, to the gold pin, thence to the bracket below, and thence back to the ground. This passage of the electric current through the reels in the cylinder causes a magnet to be moved to the left, until a small ball comes against the end of the right-hand reel; but so soon as the pendulum has made its vibration to the left, the edge of the "knee'd" plate comes against a part of the steel bar, and pushes the bar a little to the left, so as to cause the gold point of the bar to be out of contact with the gold pin. The circuit is thus broken, and the magnet, being adjusted so as to move by its own weight towards the right, instantly moves in that direction, and a pin on it strikes the pendulum rod, and gives it an impetus, until the "knee'd" plate is carried against another portion of the steel bar, and pushes it to the right until the gold point is again in contact with the gold pin, and the circuit is re-established.

3. Working clocks by magnetic electricity. The

siderably above the average, which, according to the Greenwich data, is 61° for August.

Referring the 9 a.m. wind observations to the cardinal points, it appears that the wind blew from the w on 20 days; from the s on 5 days; from the n on 5 days; from the e on 1 day.

The small range in the barometer, the high mean temperature, and the steady prevalence of westerly winds, would sufficiently indicate that the weather had been very fine generally. Consulting the table, we find that rain fell on nine days only, and at least 20 days were decidedly fine. All reports agree in stating that the weather has been favourable for the harvesting throught England. R.S.

Correspondence.

To the Editor of the Horological Journal.

Sir,—It has long been a subject of enquiry, as to the cause of the crumbling to pieces of glass tubes after having been cleaned inside by means of a metallic wire, and I believe no person has been enabled to account for it; and as a means of prevention may be of service to country watch-makers, I beg to show the cause of their going to pieces, and the means of prevention. It is simply this:—By using the wire, the tube becomes surcharged with electric fluid, and glass being a non-conductor, the charge is become insulated; and although the tube might be open, even at both ends, the fluid cannot escape, and in its endeavour to do so it breaks the tube. Nothing more is necessary to preserve the tube from breaking after cleaning, than to lay it on a table and insert one end of a wire into the tube letting the other rest on the table, and the fluid will be discharged. It is curious that the tube after being cleaned some hours should separate into pieces of various lengths, slitting longitudinally and transversely, at one end of each slit to the right, at the other end to the left. This is well worthy the attention of the contemplative. I am Sir, your obedient servant. S. L.

British Horological Institute.

NEW MEMBERS.

The following are the names of gentlemen who have become members of the Institute since our last issue:—

Messrs. J. Whitelaw, Edinburgh; Matthew Thomson, Barnsbury Villas; — Chagg; Peter Orr, Madras; Kiessler & New, 49, Spencer Street; James Pitkin, 52, Red Lion-street.

Notice.—Members forwarding their Journals to the Office, can have them bound uniform with Vols. I. and II., at 1s. per vol.

Errata.—By a clerical error, in our last number, "W. H. Hislop" was inserted instead of "W. Hislop," "force" instead of "form," (p. 4); and "Fiearieu," instead of "Fleurieu" (p. 5.)

EQUATION OF TIME TABLE

For October 1861.

Day of the Week.	Day of Mnth	At Apparent Noon — Equation of Time to be added to Apparent Time.	Difference for One Hour	At Mean Noon. — Equation of Time to be subtracted from Mean Time.
		m. s.	s.	m. s.
Tues..	1	10 23·46	0·783	10 23·59
Wed..	2	10 42·26	0·769	10 42·40
Thurs..	3	11 0·73	0·755	11 0·87
Fri. ..	4	11 18·86	0·740	11 19·00
Sat. ..	5	11 36·65	0·725	11 36·79
Sun. ..	6	11 54·06	0·709	11 54·20
Mon ..	7	12 11·09	0·693	12 11·23
Tues..	8	12 27·72	0·675	12 27·86
Wed..	9	12 43·91	0·657	12 44·05
Thurs.	10	12 59·67	0·638	12 59·81
Frid...	11	13 14·98	0·618	13 15·11
Sat....	12	13 29·82	0·597	13 29·95
Sun...	13	13 44·16	0·576	13 44·29
Mon...	14	13 57·99	0·554	13 58·12
Tues..	15	14 11·29	0·531	14 11·42
Wed..	16	14 24·04	0·507	14 24·16
Thurs.	17	14 36·22	0·483	14 36·34
Frid ..	18	14 47·81	0·458	14 47·92
Sat ...	19	14 58·78	0·431	14 58·89
Sun...	20	15 9·12	0·403	15 9·22
Mon ..	21	15 18·81	0·375	15 18·90
Tues..	[illegible]	15 27·82	0·347	15 27·91
Wed..	23	15 36·15	0·318	15 36·24
Thurs.	24	15 43·77	0·287	15 43·84
Frid..	25	15 50·67	0·256	15 50·74
Sat...	26	15 56·82	[illegible]	15 56·88
Sun...	27	16 2·22	0·193	16 2·27
Mon..	28	16 6·84	0·161	16 6·88
Tues..	29	16 10·69	0·128	16 10·72
Wed..	30	16 13·75	0·095	16 13·77
Thurs.	31	16 16.02	0·061	16 16·04

TO CORRESPONDENTS, &c.

S. Long.—If a sum of Five shillings per annum is paid in advance to the Honorary Secretary of the Institute, the Journal is forwarded, free, direct from the Office on the day of publication.

N.B.—All Advertisements to be inserted in the Journal must be forwarded to W. Hislop, Honorary Secretary, at the Office 35, Northampton Square, E.C. before the 23d of the Month.

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Town and Country.

BRITISH HOROLOGICAL INSTITUTE.

BAROMETERS: THEIR CONSTRUCTION, USE, AND RECENT IMPROVEMENTS.

A Lecture

Delivered By MR. R. STRACHAN *at the* BRITISH HOROLOGICAL INSTITUTE, *September 18th*, 1861.

MR. J. F. COLE, V. P., IN THE CHAIR.

GENTLEMEN,—The object of the lecture is to give some information respecting the barometer. The intention of the Horological Institute is to furnish its members with information rather than amusement, therefore, such a subject as the one I have selected, cannot be considered unsuitable. Recent improvements in barometers will chiefly engage our attention, but it is perhaps advisable to pass rapidly in review the mode of construction of the instrument, as well as to notice the successive improvements which have been made in it.

Many atmospheric phenomena result from the weight and elasticity of the air. When a space is devoid of air, the pressure from the outside tends to drive into it all surrounding matter. This fact was known from remote ages and was propounded under the old axiom that nature abhorred a vacuum. That notion prevailed until the time of Galileo, when it became qualified under the following circumstances. Some workmen employed in erecting a pump for the Duke of Modena, found that the water would rise no higher than about 32 feet; and by no means could they succeed in raising it beyond that height, which, however, would not answer the purpose for which the pump was wanted, and consequently its makers failed in their object. Up to that time the pump was adduced as an illustration of the commonly received dogma that nature disliked a vacuum, and here it appeared it was not so beyond a certain height.

The difficulty was referred to the celebrated philosopher Galileo, who sarcastically remarked that nature did abhor a vacuum up to a certain extent it was true, viz. to the height of about 32 feet, but beyond this point she pleased to admit of one. This conjecture engaged his attention without his coming to any definite conclusion as to the cause of the phenomenon. He made various experiments upon the subject, which after his death were continued by his pupil Torricelli, who conceived the idea that the water in the pump must be supported by the pressure of the air which was outside it. As the pressure of the atmosphere was sufficent to balance the weight of about 32 feet of water, if another fluid of greater specific gravity were used, it would force it up a less height. He set himself to experiment with a fluid heavier than water. He filled a glass tube, closed at one end, and about a yard long, with mercury, then inverted it into a vessel also containing mercury. When the tube was thus placed vertically, the mercury did not run out, as it might have been supposed that it would have done, but stood supported at a certain height. It would not run out so long as the end dipped in mercury. He was surprised to find the result so exactly in accordance with his previous views. He inquired what led the column to remain in the tube.

I have here a similar tube, filled with mercury, and placing a finger securely over the open end, I invert it into this tumbler, which holds some mercury, taking care not to remove the finger until the end of the tube dips in the mercury. Now the result of removing the finger you observe is that the mercury has fallen partly out of the tube, but a column of about 30 inches remains supported. Torricelli's experiment was precisely similar. Mercury is about 13½ times heavier than water, and accordingly Torricelli came to the conclusion that if the pressure of the air would support the water in the pump at the height of 32 feet, it would only support a column of mercury one 13½ part of that distance, which is about 30 inches. That was found to be the length of the column of mercury in his experiment. Thus it is demonstrated that the column is supported by the pressure of the air outside. It is its pressure upon the mercury in the tumbler which keeps the column in equilibrium. As the pressure of air varies the length of the column changes. The column in the tube is a weight of mercury, the pressure of which upon the surface of the fluid in the tumbler is exactly equivalent to the corresponding pressure of the atmosphere which would be there if the tube were removed.

Torricelli soon discovered that the column was by no means constant in its length. He found that it changed from day to day and even from hour to hour. He at once concluded that it was an instrument which would show the fluctuations going on in the atmosphere, arising from its changes in weight and elasticity.

Galileo may be regarded as the prophet who conceived the likelihood of the atmosphere having weight, and Torricelli must be looked upon as the discoverer of the fact. Much credit is also due to the verifier of the phenomenon. Pascal, a French philosopher, said, that if the column of air were the same weight everywhere the result would be the same in all places, but in high localities the pressure must be considerably less than in low ones, because the higher we ascend the more of the air we leave below us. He took one of the instruments to the top of a high mountain and he found that as he ascended in height the mercury descended in the tube. This verification of the fact of the atmosphere possessing weight has led to the very important application of the barometer for the purpose of measuring the altitute of mountains. It has been of much use in geographical researches for defining elevations, ascertaining the heights of mountains and hills, of the sources of rivers and of cities.

If we took a glass tube, bent in the form of U, open at both ends, and poured in mercury or any other fluid, it would rise to the same level in both limbs. If water were poured into the left limb and mercury into the right, we should find that these fluids would not come to the same level, the water would stand a great deal higher than the mercury. If the height of the mercury, above the line of meeting of the fluids, were 1 inch, that of the water would be 13½ inches. The only explanation of the difference is, that the two columns balance each other. The pressure of the atmosphere in each limb is precisely similar, but the one column stands so much higher than the other because the fluid of which it is composed is so much lighter than that of the other. If we took a tube, which, instead of having both limbs open, had only one exposed, and filled it with mercury, holding it in a vertical position, the mercury would fall a considerable distance (if the closed limb be long enough), but would remain about 30 inches higher than in the exposed limb. The question is, what supports it? The air pressing on the top of the short column. There is no pressure on the top of the tall column, but there is the influence of the air on the short one. The only conclusion therefore that can be come to is, that the pressure of the air exerted on the exposed surface is sufficient to maintain the column. Supposing the bore of the tube were a square inch throughout in area, by measuring the column so supported, and multiplying it by the weight of a cubic inch of mercury, it would be found to weigh very nearly 15 lbs. Hence the invention of the barometer led to the discovery of the important fact that the pressure of air on the surface of the earth is about 15 lbs. on every square inch, for that is the pressure necessary to support the mercury in the barometer. If we filled a tube with, and inverted it in mercury, it would be a precisely similar case.

From the circumstance that Torricelli's experiment shewed the weight of the atmosphere, the instrument obtained the name *barometer*, or measurer of heaviness, not very happily given certainly. Soon it became desirable to construct a portable instrument which could be moved from place to place. The open end of a syphon tube was made in the form of a globe, in the top of which a very small opening was left, which could be readily plugged up with paper or cork, and thus prevent the fluid from getting out, when the instrument was inverted, or carried about. In this manner cheap portable barometers are made now. But the plan most adopted is to cover over the cistern of an inverted tube leaving an aperture covered with sheep-skin or other substance which will not allow the mercury to come through but offers no resistance to the passage of air. The bottom of the cistern may also be made of skin, and moveable, and a screw applied so as to admit of the mercury being raised in the cistern and to the top of the tube, and so make the barometer portable. This is known as Fortin's plan, and answers another purpose which will be alluded to presently.

If the barometer is required only for use as a guide to the weather, either by seamen, agriculturists, or others for the ordinary purposes of every-day life, the cistern may be made of box wood, or iron, sufficiently large to give the requisite range of the column, and yet so small as to admit of the instrument being inverted or placed at length, and in any position the mercury in the cistern will sufficiently cover the end of the tube to prevent the column being broken, or any mercury leaving the tube, so that it is portable in any position, but most safely so, when carried cistern end upwards. If carried in its proper position, the movement of the mercury in the tube might introduce air, if not break the tube.

Barometers thus constructed are not suitable for measuring great heights, because

the mercury cannot perhaps descend sufficiently low. For marine purposes they answer admirably. They are suspended in gimbals, somewhat like a chronometer in its box, so as to remain vertical in every position of the ship. I should also mention that the tubes of marine barometers must be contracted in the bore, for a considerable length, so as to prevent the oscillations (called "pumping") which would otherwise be occasioned by the motion of the ship. I have known captains who have had new tubes put in barometers at a foreign port, who afterwards found them utterly useless from the extent of pumping.

All barometers should be constructed with great regard to accuracy. The marine barometer should be especially reliable on account of its great importance to navigation. Pure mercury should be employed. Mercury generally contains lead, sometimes iron also. It is necessary to wash those substances away with acetic or sulphuric acid. Then again it is requisite that the mercury should be free from air, to obtain which result it is necessary to do what is called "boiling" it in the tube, but which process is simply heating it to a very high degree of temperature, by which means small particles of air are expelled. One can tell whether a barometer has been properly "boiled" by simply holding the tube in a slanting direction, and allowing the mercury to strike the top. If the operation has been well performed the mercury will strike the top with a metallic sound; if not, with a dull flat sound, and some air is present.

I have now to speak of the manner in which the scale is affixed for the purpose of measuring. If a scale were applied to the column before you, it would show nearly 30 inches for the height. There are various modes of applying the scale. The cup or cistern being affixed to the tube in some convenient way, a moveable scale may be appended to the tube. As the mercury falls in the tube, that in the cistern must necessarily rise by a proportionate quantity. If the rising and falling were measured as fixed, it would vitiate the readings, and therefore a moveable scale has been adopted by which a correct reading is obtained. Another mode is to have the cistern bottom made moveable as represented in the diagram [of a Fortin's barometer]. The cistern bottom is made of sheep-skin, or something moveable, but not sufficiently porous to allow the mercury to leak out. The moveable bottom enables the observer to adjust the surface of the mercury to the "fiducial" or "zero" point. If it is not in contact the bottom must be screwed up, if the point dips in the mercury, it must be screwed to let it down. The scale is measured up from that point, and so the length is got accurately. You may think this a very elegant mode of adjusting the scale of a barometer, and so it is in theory, but there are objections to it in practice. Some observers prefer to allow for capacity. In this case there is a certain height which is accurately measured by the fixed scale. Above this point the readings are all less, and below all more than they should be. The ratio between the diameters of the tube and cistern supplies the data for finding the correction to be applied.

Messrs Negretti and Zambra have recently patented a new arrangement by which to adjust the mercury for reading, and also for travelling purposes. For mountain journeying the Fortin plan is somewhat objectionable. It does not stand change of climate, heat, cold, or moisture, and knocking about for any length of time. The following plan was hit upon:—Instead of making the bottom of the cistern moveable, they made the whole of the cistern upon a screw principle, so that it could be screwed up or down to suit the neutral point, and screwed close up for portability. The cistern was made of iron, and they platinised the screw to avoid the inconvenience of rust. However, there is some difficulty in adjusting the cistern for observation, because it is needful to apply two hands, and in observing, it is requisite to have an eye glass, consequently there is only one hand disposable. For portability and travelling there are none made on a better principle. In this, as in other adjustable cisterns, there is an inner cylinder of glass, and slits, or openings, are left in the outer, to permit of the surface of the mercury and the neutral point being seen.

Gay Lussac devised a barometer on the syphon principle. It is employed as the "weather glass" with which all are familiar. When such barometers are seen in mahogany frames, some mystery is thought to be attached to them. Some people are as much astonished at them as the Chinese were when the celebrated Arnott was speaking to them of the barometer. They imagined it was the gift of one of the gods to guide the christians through the perils of the trackless seas. Gay Lussac's barometer is made of a tube,—similar to a drawing shewn. The short limb is open to the air, and on the mercury rests a round ball, made generally of ivory. To this ball a string is attached which passes over a pulley. At the other end the string carries another lighter weight. The one which rests on the surface of the mercury rises and falls

with it. When the mercury rises in the short tube it pushes the ball up, the counterpoise falls and thus moves the pointer, placed on the pulley, to the left. When the mercury falls it brings the index to the right. The motion of the index alone is visible on the dial plate; the mahogany frame supports as well as renders the instrument ornamental and portable. These instruments are very useful as household barometers, but scientifically they are regarded as mere toys. They are very liable to get out of order, and have generally a bad adjustment of scale. They are several tenths of an inch out sometimes, and the error is not constant for all parts of the scale. However, as a glass to be consulted in a house, this form is not only ornamental but useful also.

The *mountain* barometer made on Lussac's principle is, perhaps, the best in use. The short tube is closed and punctured only with a very small hole. The hole is generally closed over by a tightly tied piece of wadding which permits the access of air, but prevents the mercury from escaping when the instrument is packed for travelling. Such mountain barometers are read by observing the length of the long and short columns, and taking the difference. The scale is engraved on the brass tube or case. So accurately can this be done, that the barometric height can be obtained to the thousandth part of an inch.

(*To be continued.*)

LEVER PALLET ANGLE METER.

By J. F. Cole.

To the Chairman of the Museum and Gauge Committee.

"Sir,—In fulfilment of a promise to deposit in the Museum an originally-designed instrument, referred to in a Paper read by me before the Members of the Horological Institute, June 7th, 1859, I take this opportunity of placing in your hands two completed instruments, the same being confided to your care for the Museum, on condition of my withdrawing them on application at any time I may require to do so. I also beg to state, that the desirability of scientific and reliable means for determining the required angles and proportions for insuring correct results, and for facilitating the process of lever escapement making, has induced my constructing the above-mentioned instruments, which realizing these objects, will I believe, be found of utility for those particular purposes.

"The following description I enclose for publication in the Journal, and am Sir, your's very respectfully,
"11, Great James-street, W.C., *Oct. 7th*, 1861." "James F. Cole."

Description of an Instrument for testing the mechanical value of any angle for the impulse plane of Lever Pallets, and for determining with precision the diameter of the roller and place of the ruby pin, for producing any required arc of action on the balance, in exact degrees, as the ultimate arc of impulse in Detached Lever Escapements.

The above-named instrument consists of a flat plate of brass, as a foundation for the subordinate parts, the plate being formed as shewn at *a*, *b*, *c*, *d* (*fig.* 1), *c*, being a central hole through the plate. On the upper surface of the plate, from *a* to *b*, is a divided scale of 60 degrees, numbered 10, 20, 30, 40, 50, 60, outside the divisions, and 5, 10, 15, 20, 25, 30, inside; this inner scale *to a limited extent* representing arcs of motion.

On the horizontal line drawn to the centre hole, is placed the zero of each set of figures, and this line accords with the base line of the triangle laid down in the diagrams in the Institute. At the back of the brass plate is a steel arm carrying a cylindrical steel stud, or axis, fixed to the arm, but fitted to move just freely in the centre hole of the plate, this end of the stud *c* passing through and projecting about 1-8th of an inch above the upper surface of the plate, and the length of the arm at the back extending half an inch beyond the circular edge of the plate. Attached to this projectile end of the arm, is a tie-piece and index *d*, with a screw *g*, for fixing the arm to any required position relatively to the scale of degrees; from the inward point of the index, a right line drawn on the arm, through the centre of the steel stud *c*, indicates the face line of a plane, formed on this projectile portion of the stud *c*, by cutting away exactly half its diameter, so that when the index is at zero on the scale, the face of this plane being in the zero line, will agree in direction with the pallet centre of motion. On the upper surface of the foundation plate, is a small plate of steel *e*, slotted at both ends, to admit of longitudinal motion on the horizontal zero line, to or from the centre stud *c*, for suiting the various sizes of pallets, the pallets for trial fitting free on a small steel centre pin *f*,

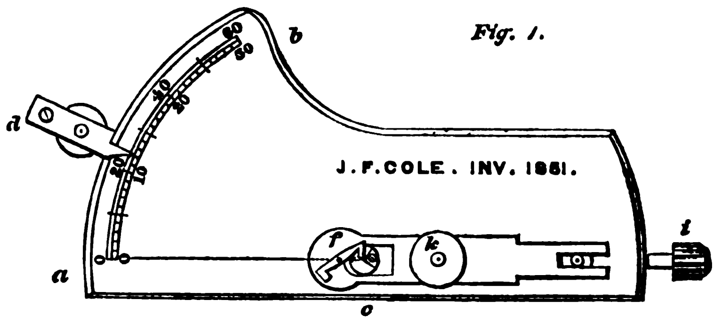

Fig. 1.

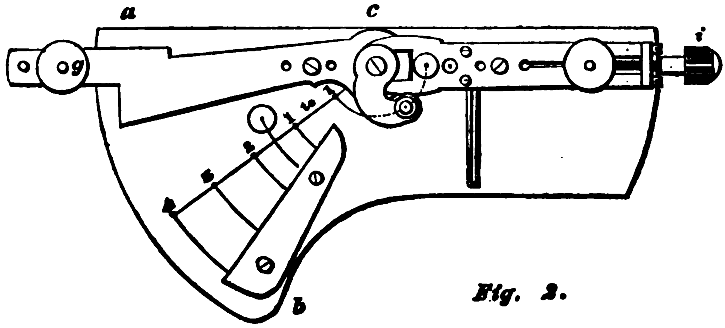

Fig. 2.

fixed in the steel sliding piece *e*, precisely over the zero line on the brass plate.

It is here necessary to advert to the principle exhibited in the diagrams, where the extreme delivery point of the second pallet, is made the root of a line diverging from the zero line, outside the pallet axis, this line producing, what I have called "the angle of divergency." In this instrument, the root of the diverging line leads from the true mechanical centre of the stud plane, that point on the plane being determined by a rectangular steel check, against which and the stud plane, the delivery point of the second impulse plane of a pair of lever pallets, is made to rest while the angle is being tested; this operation is readily performed by placing a pair of lever pallets free over the centre pin *f*, in the steel sliding piece *e*, and pressing the pallet lightly against the check and face of the centre stud or tumbler *c*, so that by *adjustment* the delivery point of the second pallet will fall exactly into the rectangular recess of the stud, the slide piece should then be fixed by the screw *k*, this done, move the index arm from zero to any degree on the scale, at which the two faces of the centre stud and the second pallet impulse plane strictly correspond, and at whatever point this may happen, the degree marked by the index on the inner scale will be the true measure of the pallet arc of motion, though the angle producing it, will, for an 8, 10, or 12 degree pallet, comprehend double that number of degrees from the zero line as shewn by the outer scale, and also by the diagrams in the Institute. With regard to the double number, it must be observed, that the figure 10 is the only figure necessary on the inner scale, it being the mean between 8 and 12 degree pallets, the highest and lowest arcs ordinarily employed, and within those limits, the double indications for the angle are correct.

In confirmation of this theory, means are provided in this particular instrument, for mechanically proving the effectiveness of the principles adopted in its construction, by the addition of two temporary brass cocks, with conical centre screws, for attaching and pitching the wheel and pallets to a proper acting depth; this if done in the instrument, as it may be by the steel screw *i*, at the narrow end, the acting arc of the pallets will be indicated on the outer scale, by degrees of half the value given by the inner scale, viz. 24 for 12 degrees, each process completely demonstrating the correctness of the other. Beyond this demonstration, the temporary cocks will not be required, as in the future use of the instrument, the pallet arc of motion will be as correctly determined by

J. F. G.

BERTHOUD'S DESCRIPTION OF HIS MARINE TIME-KEEPER, No. 8.

TRANSLATED FROM HIS "TRAITE DES HOROLOGES MARINES."

Paris, 1773. *Chap.* x. *page* 271.

(*Continued from page* 21.)

Experiments with the Chronometer No. 8.

The marine chronometer No. 8 being entirely finished I set it going with a spiral, which made two and a half turns, but bent in large coils. The motive force being 9 lbs. it advanced half a second in two hours. With a force of 4½ lbs. slow twelve seconds in two hours. The large arcs being quicker than the small ones, I adapted to the chronometer a spiral which made seven turns and ten and half lines of diameter the oscillations being sensibly isochronous, but the spring was too weak.

I observed, that after the chronometer had gone some time, the banking pin of the balance, which before was at 0, had changed to five degrees, which showed that the coils of the spring had become more open.

I put to the chronometer the spiral spring No. 3, after having proved it on the elastic balance, it made eight turns and drew thirteen grains to five degrees, and was eight and a half lines in diameter, the progression of the force being perfectly constant, the oscillations ought to be isochronous. I tried in effect this spring by making the chronometer go with weights of different amounts, and the oscillations, although very unequal, in extent were isochronous.

The spiral No. 3, thus tried, was acknowledged very good, and served to prove my theory on the springs, and on the laws which they ought to follow, viz. the progression of their forces, but I was fearing lest the spring when it came to be tried in different temperatures, and especially in heat, should change its form, and open or expand its coils, as I had already experienced with others. I then attempted to fix its form by tempering it, but I had the misfortune not to succeed, and to lose an excellent spring, because the heat made the spring open and made it change altogether its figure. I then took the resolution to soften and straighten it, in order to take the dimensions for making others similar to it. The spring was 12 inches and 4 lines long (13·15 Eng. in.), and $\frac{7}{12}$ wide (·169), and $\frac{6}{48}$ thick (·0093), and weighed 41 French grains. Then, as 122 Fr. grs. : 100 troy : : 41 : 34 troy grs., the weight of his spring.

I adapted to the chronometer, a spiral, No. 4, making seven and three-quarter turns, the oscillations were very nearly isochronous. I set the chronometer going, giving it different inclinations, and I proved that although the arcs of vibrations should change a little, their extent nevertheless did not affect the going of the chronometer, and, satisfied upon so important a point, I ought to have adhered to this spiral, by leaving it in that state, but the same fear of its changing its form was still tormenting me, and I was venturesome enough to attempt to temper this spring, taking all the precautions which seemed likely to prevent it changing its form by making it hot,—all this was useless, for I lost this spring also. At length, however, these two accidents set me about seeking the means of fixing the springs permanently without tempering them, and in this I fortunately succeeded by the method described in article 173. I will again show the application of it when treating of the manipulation. This method consists in heating the springs pretty strongly, without nevertheless making them change colour, then they open a little, and by plunging them thus heated into water, they will not change their figure so long as they do not experience a heat greater than that they were thus fixed at. I put to the chronometer, a spiral, No. 7, which made full seven and a half turns, draws thirteen grains. The large arcs described by the balance being quicker than the short ones, I thinned at different times the exterior turn of the spiral, in order that by this means I might succeed in rendering the oscillations isochronous, the large arcs the slower, being the contrary effect to those which I had made before, and which was easy to correct in shortening the spiral.

I was inclined to heat this spring pretty strongly, to blue the end and thereby fix its form, but this too great heat made me lose another spring. These different accidents far from damping my ardour, served only to encourge me, since it is by these different obstacles that I am enabled to give to this part a perfection that I should have been ignorant of without these difficulties.

At length, after different endeavours to obtain a good spiral spring, after having lost so many very good ones, I stopped at that of No. 19, which was of good strength, and with which the oscillations were sensibly isochronous, the large arcs a little more prompt by about half a second per hour, but

for want of time to perfect it, I employed it in this state.

The spiral being chosen, I regulated the chronometer by charging the balance with three small masses, to make up the necessary weight.

The chronometer thus regulated, I polished it, and after having wound it up with care, I occupied myself with the compensation, in finishing the trials and bringing it to a proper state of adjustment. These are the dimensions in which I have fixed the mechanism of the compensation when it was completely regulated. The pin of the little arm of the great compensation lever, which acts on the frame, is distant from the centre of the lever 3 lines (= ·267 inch), the large lever from the point of contact of the screw of the box to the centre of the lever is 30 lines (= 2·67 inches), the screws of the box of the spiral pin is distant from the centre of its axis 3 lines (= ·267 inches. The chronometer being then finished and regulated, I set it going without touching it any more, from the 13th September, 1768, to the 12th of October following, the eve of the departure of this chronometer for Rochefort, during this time its going was sufficiently regular, that I ventured to hope that it might succeed.

State of the Marine Chronometer No. 8, *at at Paris, the* 13*th of October*, 1768, *before being transported to Rochefort.*

The thermometer being at 13½ Reau. (= 63 Fah.), the rateau or index of the spiral being at 13½ degrees, the arcs of vibrations ·240 degrees. The chronometer No. 8, having arrived at Rochefort, I found that the thermometer being at 14 degrees, the index of the spiral stud was only 12 degrees. I attributed this change of the spiral stud to the violent shaking of the carriage, which had caused the compensation lever to turn, as it was only put on friction tight upon the staff. I fixed it afresh, and the thermometer being at 13 degrees, I altered the index to 13 degrees, and left it in this state; I made afterwards many experiments on the rate of this chronometer in a great heat &c. On my return to Paris, I prepared the table of corrections to be employed for correcting the going of the chronometer, during the different temperatures. Here is the table which I prepared for the Minister of Marine to be sent to Messrs. Fleurieu and Pingré.

Table of the Corrections which are necessary to apply to the time shown by the Marine Chronometer No. 8, *in order to estimate its rate in the under-mentioned different temperatures.*

The chronometer No. 8, is supposed to be regulated at a temperature of 15 degrees above the freezing point, it loses by the cold as well as by a great heat.

Degrees above the Freezing Point.

Reaumer.	Fahrenheit.		"
5	43½	slow in 24 hours.	$1\frac{5}{7}$
10	54½	ditto ditto ...	$0\frac{5}{7}$
15	66	supposed regulated	0
20	77	slow	1¼
25	88½	Ditto	2½
32	104	Ditto............	6¼"

Extract of the Rate of the Marine Chronometer No. 8, *during the trial made at sea, taken from the Journal that Mr. de Fleurieu published by order of the king.*

At Rochefort, from the 14th of November to the 7th of December, the same year at a mean, the Marine Chronometer No. 8 lost upon the mean time 4",12.

At L'Isle D' Aix.

By the observations compared with the 22d December, 1768, and with the 18th January, 1769, at a medium was slow 5",09.

At Cadiz.

From the 1st to the 14th of March, the daily losing was 8",545.

At La Praya.

From the 13th April to 18th of April, the daily losing rate was 11",61.

At Fort Royal.

From 11th to 15th of May, the daily loss, 13",475.

At Cap Francois.

From the 30th May to 11th of June, daily losing 12",83.

At Angra.

From 25th to 31st of July, daily losing, 16",75.

At Sainte-Croix.

From 18th to 23d of August, daily losing 19",275.

At Cadiz.

From 4th to 10th Oct., daily losing 15",93.

At L'Isle Daix.

From 1st to 13th Nov. daily losing 18",605.

The experiments made with the Marine Chronometer No. 8, since its return from its trial at sea, serving to establish the causes of its losing rate.

To obtain with certainty the causes which made the chronometer lose during the trial at sea; I prepared, before touching the chronometer, a plan which was to regulate each operation or experiment that I proposed to make. To arrive at this end, I determined it as I have described at the end of No. 6 (716 fol.) to which we refer. It will suffice to say, that this plan was yet more particularly destined to No. 8, because I was much more attached to it, and therefore more anxious to prove the cause of the errors

in this machine, than that of No. 6, the latter being less perfect in many respects than the other. It is in following the spirit of this plan that I dare flatter myself to be certain of the causes of the losing of No. 8, and by this of correcting or to be capable of perfecting the marine chronometer; but before treating of this latter subject, I must here give an account of the experiments and observations which I made.

Having taken the movement out of its (tambour) box, I did not see the least mark of rust, nor spot, the polish of the steel had not changed colour, there was not the least dirt nor dust attached, neither to the cylinders nor to the axle; in a word, the chronometer was as clean as when I wound it up before its departure. At Paris, before the departure the chronometer, was losing 4″ in 24 hours, the thermometer being 13¾, and the index 13½. At Rochefort, the chronometer was losing 4″,12, and at the end of the trial it was losing 18″,60, therefore the losing had increased to 14″,48 in 14 months. We intend to give an extract of the experiments which were made in order to assign the causes of this losing, and the quantity of each.

First Experiment:—The arcs of vibration before the departure were 240 degrees; on the return of the chronometer, I found that they were 210 degrees.

Second Experiment:—At Rochefort, the thermometer being at 13 degrees, the index was 13; on the return, the thermometer being at 14, the index was 13; the difference 1 degree or thereabout.

Third Experiment:—The arc of vibration described by the balance (the movement being ont of its case), the watch loses 29″ in 24 hours; and having added a weight of 2¾ lb., the arcs being 240 degrees, the watch lost 21″ in 24; therefore a difference of 8″ was caused by the addition of weight, and the arcs were increased 30 deg.; this adjustment was made before anything was changed in the movement.

Fourth Experiment:—Having put oil to the escapement, without taking away the old, which remained and was coagulated, the chronometer lost 31″¾, instead of as before it lost 29″ in 24 hours, the difference caused by the oil 7″¾. The arcs became 230 degrees, after having put the oil to the escapement; therefore the oil had made the augmentation 20 degrees. This effect is caused by the fresh oil, which had diluted the old oil.

Fifth Experiment:—12 oz. added to the going weights had caused the balance to describe 240 degrees instead of 230, and the difference in the weights and in the extent of the vibrations, has made the chronometer lose less, 2″½ in 24 hours; which, with the third experiment proves that the spiral is oot isochronous.

(*To be continued.*)

LIVERPOOL OBSERVATORY.

Rates of Chronometers on Trial for Purchase by Shipowners and Captains in the Mercantile Marine.

The following Table exhibits the results of the first trial of chronometers, by means of the arrangements recently made at the Liverpool Observatory. The new chronometer room, which is 28 feet by 18 has a large double sky-light; the side walls are double, having a cavity between them. The whole room can be warmed by hot water pipes which are carried under the floor, and there are two warm air chambers placed in the room, each of which will hold upwards of 100 chronometers; the tops of these chambers are made of plate glass, so that the chronometers in their boxes with the lids open may be compared as frequently as desirable, and their rates in different temperatures ascertained without moving them from one place to another. The heating is all by gas, the pressure of which is regulated by a governor. The advantage of this arrangement is that the temperature can be kept the same for the whole week to within two or three degrees, and the change when made is not sudden but gradual, occupying some four or five hours for an alteration of about 15 degrees, this being the largest change to which the chronometers are subjected at any one time.

Shipowners and captains will see at a glance the quality of each chronometer; and when a selection is made, the rates for those temperatures to which ships are most frequently exposed will be found in the Table.

Columns 1 and 2 contain numbers
Columns 3 to 7 show the mean daily rate for each of the five weeks, *gaining* when no

sign is used, and *losing* when the — sign is used; the range of temperature is given at the bottom of each column.

Column 8 is the mean of columns 3 and 7, and column 9 the mean of 4 and 6.

Column 10 shows the rate in the highest temperature. The object of this arrangement is to separate as far as possible, the irregularity of performance due to change of temperature from that arising from other causes.

Column 11 shows the greatest change of rate between any two weeks from all causes of irregularity combined, and column 12 that portion which is due to change of temperature.

Column 13 shows the mean of the five extreme differences between any two days of each week; by the numbers in this column the steadiness of daily rate may be seen.

29·304, at 5 p.m. of the 25th, which gives a range of 0·946 of an inch.

The mean temperature due to September, according to Greenwich results, is 57°; which is about the same for the past month.

On the 3d at 6½ p.m. was a splendid sunset, the clouds in the western horizon of a deep crimson or copper colour.

On the 7th was a fresh gale from W to NW nearly the whole day.

Between the 10th and 14th the wind veered completely round the compass, from NW, through N, E, S, and W to N.

On the 13th at 5 p.m. part of a rainbow in the SE.

On the 14th in the a.m. was a fresh gale from SW to W; and the wind continued very strong from northward during the 15th.

On the 23d a strong gale blew from the westward.

Referring the wind observations, at 9 a.m. to the cardinal points, it appears the wind blew from the N on 6 days; from the E on 2; from the S on 9; and from the W on 12 days; while it was calm on 1 day.

Rain fell on 16 days. Only 10 fine sunshiny days can be counted.

The weather of September has been stormy and rainy, while the prevalence of SW winds has maintained an average temperature.

In connection with the weather record, the following extract from a leading article in the *Shipping and Mercantile Gazette*, of September 18th 1861, is interesting:—"The whole of our correspondents agree in stating that the yield of wheat, as to quality, is by far the best on record, but that with some few exceptions, the yield does not come up to what may be termed a full average. When however, we consider the splendid condition in which the wheats have been secured, and consequently the large additional quantity of flour produced, compared with most previous years, there is no question whatever but that a most valuable crop has been secured, both for the millers and the consumers, as well, of course, as for

the growers. Indeed, it may be stated that the present year's growth is yielding at least one-third more flour, taking measure for measure, than the crop of 1860."

R. S.

MAGNET.—One Magnus, a shepherd, first discovered the loadstone by its sticking to the iron of his sandals, whence the name "Magnet" was given to the stone or magnetic Needle.—*Practical Navigator.*

British Horological Institute.

NOTICE.

A Course of TEN LECTURES ON MECHANICS will be given Fortnightly at the British Horological Institute, during the months from November to March,—commencing on Tuesday, November 19th, 1861, by W. HISLOP, Esq., F.R.A.S., *Hon. Sec.* Chair to be taken at Half-past Eight precisely.

Division First.

Nov. 19 ... Lecture 1.—Introduction: Relation of the Science to Horology—Properties of Matter.
Dec. 3 ... „ 2.—Statics—Force—Equilibrium.
„ 17 ... „ 3.—Centre of Gravity

Division Second.

Dec. 31 ... Lecture 4.—Dynamics—Laws of Motion —Inertia.
1862.
Jan. 14 ... „ 5.—Second and Third Laws of Motion—Compound Motion—Reaction.
„ 28 ... „ 6.—Central Forces — Rotatory Motion.
Feb. 11 ... „ 7.—Gravitation and Laws of Falling Bodies.
„ 25 ... „ 8.—Gravitation (Second Lecture) Projectiles—The Pendulum —Effects of Gravitation on the Heavenly Bodies.

Division Third.

March 11 ... Lecture 9.—Mechanical Powers: Lever, Wheel and Axle.
„ 18 ... „ 10.—Pulley — Inclined Plane— Wedge—Screw.

NOTICE TO MEMBERS.

Those Members who have not received their Cards for the current Subscription are requested to apply at the Office.

Subscriptions due at the Michaelmas quarter should be sent by Stamps or Post Office Order, payable at Goswell-road to W. HISLOP, *Hon. Sec.*, 35, Northampton-square, E.C.

NOTICE.—Members forwarding their Journals to the Office, can have them bound uniform with Vols. I. and II., at 1*s.* per vol.

All Communications for this Journal should be addressed to the EDITOR, *before the 25th, at the Office,* 35, Northampton Square, Clerkenwell.

EQUATION OF TIME TABLE

FOR NOVEMBER 1861.

Day of the Week.	Day of Mnth.	At Apparent Noon. Equation of Time to be *subtracted* from Apparent Time.	Difference for One Hour.	At Mean Noon. Equation of Time to be *added* to Mean Time.
		m s.	s.	m. s.
Fri. ..	1	16 17·48	0·028	16 17·49
Sat. ..	2	16 18·14	0·006	16 18·14
Sun. ..	3	16 17·99	0·041	16 17·98
Mon ..	4	16 17·01	0·074	16 16·99
Tues ..	5	16 15·22	0·108	16 15·19
Wed ..	6	16 12·62	0·143	16 12·58
Thurs .	7	16 9·19	0·178	16 9·13
Frid...	8	16 4·93	0·212	16 4·87
Sat....	9	15 59·84	0·246	15 59·77
Sun...	10	15 53·93	0·280	15 53·85
Mon...	11	15 47·18	0·315	15 47·09
Tues ..	12	15 39·61	0·350	15 39·52
Wed ..	13	15 31·21	0·385	15 31·11
Thurs .	14	15 21·98	0·420	15 21·87
Frid ..	15	15 11·91	0·454	15 11·80
Sat ...	16	15 1·01	0·489	15 0·89
Sun...	17	14 49·27	0·524	14 49·14
Mon ..	18	14 36·70	0·558	14 36·57
Tues ..	19	14 23·30	0·592	14 23·16
Wed ..	20	14 9·09	0·626	14 8·94
Thurs.	21	13 54·05	0·660	13 53·90
Frid ..	22	13 38·20	0·694	13 38·04
Sat...	23	13 21·53	0·728	13 21·37
Sun...	24	13 4·07	0·760	13 3·91
Mon ..	25	12 45·83	0·792	12 45·66
Tues ..	26	12 26·82	0·823	12 26·65
Wed ..	27	12 7·06	0·854	12 6·89
Thurs.	28	11 46·57	0·884	11 46·40
Fri ...	29	11 25·36	0·913	11 25·19
Sat ...	30	11 3·46	0·940	11 3·29

TO CORRESPONDENTS, &c.

*** Clock and Watchmaking by THOMAS REID is published by Messrs. Blackie & Sons of Edinburgh, and Paternoster Row, London.

N.B.—All Advertisements to be inserted in the Journal must be forwarded to W. HISLOP, Honorary Secretary, at the Office 35, Northampton Square, E.C. before the 23d of the Month.

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BRITISH HOROLOGICAL INSTITUTE.

ON THE PENDULUM.

Two Lectures

Delivered by E. D. Johnson, Esq., F.R.A.S., *for the* Horological Institute, *at* Spa-fields Lecture Hall, *October 16th*, 1861.

Mr. Klaftenberger, V.P., in the Chair.

Gentlemen,—I have to claim your indulgence for any short-comings of mine which may, perhaps, cause you disappointment, on the ground that this is my first attempt at lecturing. I think I hear you asking, "Why, then, did you call us together, if you doubted your ability either to amuse or instruct?" I answer that imaginary question, by stating that I have long seen the necessity of making a beginning to such a series of lectures as from their purely practical nature might supply matter for thought, and be of immediate application by the denizens of a district so eminently practical as Clerkenwell. A lecture is either an argument or a discourse on a given subject arranged in a general or specific manner, and it will have answered every purpose if it supplies some information and stimulate to the acquirement of more on the part of the hearer, and when the time has been occupied without any sense of weariness. It is quite clear that no scientific subject can be exhausted in a single lecture; but, on the contrary, all that can be done is to cull the various choice morsels the subject presents, so as to enable the hearer to absorb as much as possible without such a bewilderment as results in the loss of benefit from the whole.

The subject I propose to handle this evening is one which might occupy volumes. It is intimately connected with other important and interesting studies, such as mechanics, dynamics, and astronomy; and although we shall be forced to allude to them in our path, we shall only be able to spare a moment for each in passing.

Definition of a Pendulum.

Every body supported by a horizontal axis passing through it at a point more or less distant from its centre of gravity, can only be in permanent equilibrium when that centre of gravity hangs immediately below the axis. If free to move, and that centre of gravity be drawn from the perpendicular, it will swing from side to side until friction destroys its motion, and enables it to settle down again in its former position. Every such pendulous body is called a "Pendulum;" but we only apply that word to such forms of bodies as are specially designed to perform certain offices by their motions, which we call indifferently by the names "oscillation" or "vibration;" but to prevent confusion I shall call them "vibrations."

Scientific Uses of the Pendulum.

The pendulum is not only an instrument of importance in daily life as a timekeeper, and as the corner-stone to the art which gives much of its vitality to this district, but it is of immense importance in other sciences. It is an indespensable adjunct to an observatory. It has been the means of exhibiting the variations in the force of gravity at different latitudes, and of helping to corroborate the calculations of those who have sought to determine the figure and density of the earth, and the modifications of the force of gravity by the centrifugal effects of the earth's rotation on its axis.

The lecturer here gave a short explanation of the difference between the polar and equatorial diameters of the earth, and of the manner in which the pendulum was employed to determine it. He showed that its indications of that difference were so plain, that it enabled Newton at once to determine it as 1-230; the figures arrived at in the calculation of that great philosopher being relied upon at the present day.

Varieties of Pendulums.

Pendulums are of three kinds—the simple, the compound, and the conical. The simple are those which we have principally to deal with to-night, because their rudimentary nature is best calculated to aid our first attempt to understand the laws that govern the motions of pendulous bodies.

The Simple Pendulum.

A simple pendulum consists of a heavy body or molecule suspended by a flexible string or rod of any length, the whole weight of the instrument being supposed to

be concentrated in the "bob," as the weight is called.

The Compound Pendulum.

A compound pendulum is one in which the rod itself has considerable weight, and every part of which, if freed from its connection with the remaining parts, would constitute a pendulum. Thus the compound pendulum may be regarded as a group of any number of pendulums, and hence the name "compound."

The Conical Pendulum.

The conical pendulum may be either simple or compound. It is one the bob of which describes a circle, the motion of which is continuous, and the rod or line of which describes a cone, from which circumstance its name is derived.

Properties of the Pendulum.

The first noticeable property of the pendulum is that the time it takes to vibrate is determined by its length, and not by the weight of the body swinging. A due following up of this fact leads us to the knowledge of all the fundamental principles of the pendulum, namely, that its time is proportionate to the distance apart of the point of suspension and the centre of oscillation, or that place where, if the whole weight of the pendulum were concentrated, the time of the vibration would remain the same.

The lecturer here illustrated the manner of finding the centre of oscillation, and showed its relation to the compound pendulum.

Principle of the Pendulum.

The strict mathematical principles that govern the motions of pendulums have been examined with great care by many able men, and the results of their labours may at all times be found in books; but there are few men, even amongst those practising the art of horology, able at a short notice to explain the phenomena exhibited by the pendulum, so as to enable any one to comprehend it without reference to authors. I will endeavour to give a popular explanation of its principles.

Let us, in the first place, ask ourselves what we do when we draw the bob of a pendulum to one side of the perpendicular. It is evident from this diagram that in so doing we raise the weight from a lower to a higher level, from which gravity constantly gives it an inclination to descend; but gravity alone always acts as a perpendicular pull, and must, therefore, have its effect modified if the body be prevented from following a direct downward path. This latter being the condition of the bob of the pendulum before us, in consequence of the line to which it is attached constraining it to move in a circle around the point of suspension, let us, therefore, observe the path of the bob in its descent. You will perceive from this diagram that the bob may be said to pass along the side of a right-angled triangle, of which the shortest side is perpendicular, and in length the distance between the highest and lowest points of the arc of vibration contemplated. You will now observe that the weight is actuated by gravity in a very indirect way, namely, at an angle proportionate to the relation between the long side of this triangle and the short perpendicular one, which, as before stated, is the measure of the force expended, that is to say, gravity exerted through the distance between the highest and lowest points. Calculation proves that the force expended is the same in both paths, by the fact that a body descending acquires the same velocity on arriving at the lower point by the long slanting path as it would have had if it had fallen the distance direct, and that whatever the proportion of the sides of the triangle. Now as the path of the weight, and therefore the length of the side of this triangle, is determined by the distance of the centre of motion, it follows that as the time occupied by a constant force in achieving a given distance must increase with the distance it has to move the weight, the length of the radius line determines the time by increasing or diminishing the length of the path it has to travel in descending to the lowest point, and the proportion between this cause and effect is well known as that of the square to the square root; that is to say, the time varies as the square root of the length. In other words, to double the time you must quadruple the length; to diminish the time to one-half, you must divide the length by four. Taking any length as the unit, the multiples of that unit must be multiplied into themselves to determine how many times the unit must be increased to give a corresponding vibration—as, twice the time, four times the length; three times the time, nine times the length, and so on; because it requires an increase of the length of the radius in that proportion to reduce the directness of the force of gravity in the degree indicated. In short, the longer the pendulum the greater the distance horizontally the weight has to travel for any given amount of perpendicular descent; and the shorter, exactly the reverse. This effect is also aided by the slow

beginning of the motion, consequent on the approximation of the long line in the triangle to the horizontal, and consequent indirectness in the fall

The next and most important property of the pendulum, that which makes it so admirable a time measure, is the remarkable equality of the times of its vibrations whether they be long or short. Here, again, mathematical investigation of the subject has long since satisfactorily answered the question why such should be the case; but as there is room for a popular explanation, I will endeavour to make the matter clear without having recourse to figures. At the first view it appears paradoxical that so constant and unvarying a force as gravity should carry the same weight over a long space in the same time as over a short one; but all paradox will disappear as we proceed, as in the former case, in carefully considering what takes place during the course of each vibration. For this purpose I will return to our simple pendulum. When a pendulum hangs at rest there is no suspension of the force of gravity; it then acts simply as a pull upon the point of suspension, without any tendency, of course, to produce a horizontal motion; but when moved from that position it endeavours to return with a force proportionate to the amount of deflection; because as we approach that point where the rod or line ceases to control the motion, gravity is left to exert its full force, namely, in a perpendicular direction. This point of course is on a level with the point of suspension, as will be evident if we remember that the line is perfectly flexible, and therefore at that point must cease to exert any influence on its motion. Now, as the amount of force expended is measured by the distance fallen through, and as the velocity of a falling body starting from a state of rest is a constantly increasing one, it follows that the larger the distance the body has to fall the greater the velocity it can acquire, and therefore the greater the amount of space it can fall through in proportion to the time it has been in motion. Thus the bob of a pendulum being moved to one side, has to travel a large distance horizontally to fall a given measure; but that proportion of horizontal motion decreases with every subsequent deflection from the perpendicular until it approaches a direct fall; so that the increased activity or efficiency of the force of gravity of the more direct fall suffices to acquire a momentum sufficient to travel the rest of the distance in the residue of the time. Strictly speaking, the long and short arcs are not performed in the same time; but the consideration of that difference belongs to the second of my lectures.

The Conical Pendulum.

The conical pendulum is not at all different from the other form, so far as the course of its motions is concerned; but by reason of the path of the bob being a circle it brings it within the range of new phenomena, and it therefore becomes necessary to contemplate it from a new point of view. Having put such a pendulum in motion, it would, if left to itself, describe a spiral, as it were, on the surface of an inverted cone, the base of which would be the point of rest or equilibrium, to which its constant tendency would be to return, but the height of which would be determined by the length of the rod or line. By observing two lines, one represented by the rod, and the other passing from the bob to the base, you will again perceive that the distance to be travelled horizontally in proportion to the height fallen is governed by the distance of the point of suspension, and the consequent modification of the force of gravity, measured, as before, by the angle formed by those lines.

The Centrifugal Force.

We have here to notice a new force, called the centrifugal, or flying from the centre.

The lecturer here illustrated, by means of a diagram, a series of tangential lines, showing what the centrifugal force consisted of. This centrifugal force is determined by the velocity of the revolving body, and is manifested in a conical pendulum by the height above the base line at which a bob is maintained; any increase of force, and consequently of velocity, causing the bob to recede from the centre, and constrained by the rod or line to rise higher, and consequently to describe a larger circle. Here the efficiency of gravity being proportionately increased, the motion is accelerated, and so the long journey and the short one are performed in the same time. The natural time of the conical pendulum is proportionate to the ordinary pendulum, as one circumference to two diameters; that is to say, a circular pendulum makes one of its circles whilst the same length of vibrating pendulum makes two vibrations. There are peculiar influences affecting the motions of circulating pendulums which have not received complete investigation, but which have, nevertheless, to be admitted into our consideration, seeing that they influence the results for which we construct these instruments. Thus, a pendulum intended to vibrate in a plane, if free to move in all directions

has a strong tendency to take up the circular path, and that in spite of any amount of care in the equal distribution of the mass around the centre. No doubt this effect is referable to the diurnal motion of the earth, and although small, is so constant that it requires perpetual counteraction.

The application of this peculiarity, like that of the other principles enumerated, belongs to the second part of this lecture.

BAROMETERS: THEIR CONSTRUCTION, USE, AND RECENT IMPROVEMENTS.

A Lecture

Delivered by MR. R. STRACHAN *at the* BRITISH HOROLOGICAL INSTITUTE, *September 18th*, 1861.

MR. J. F. COLE, V. P., IN THE CHAIR.

(*Concluded from page* 30.)

It is very common to find barometers erroneous. Mr. Hartnup, the astronomer of Liverpool, frequently verifies barometers for captains at that port, and he has found them, in some instances, nearly an inch in error, some reading too high and some too low, an amount of much consequence in observations used for scientific purposes, and the logs of ships are now often consulted to aid philosophical inquiries. Some have been found so bad that the mercury would not descend lower than 29 or 28½ inches. The marine barometer should be capable of shewing at least 27 inches. The value of a barometer at sea is to show depressions which foretell storms; but if the mercury cannot descend, how are persons to be warned against the coming evil? Many cases of a similar nature have come under my knowledge. The way in which the fault may be detected is by captains bringing their instruments to the observatory to be verified. Means have been provided for obtaining artificial pressure; they are put into an air-tight case, with a glass front; the air is pumped away, and the mercury is brought as low as required,—so low as 10 inches it *could* be brought. Many barometers have been found which by no possible means would read lower than 29 or 28½ inches, owing to the smallness of their cisterns, which would not permit of a sufficient descent. Hence the necessity of having each instrument verified with a standard. Again, the mercury may be made to stand higher by forcing air into the chamber; and thus marine barometers are compared with a standard from 31 to 27 inches, beyond which limits the column never ranges at the sea level.

It is necessary to apply certain corrections to barometer readings, if they are used scientifically. Mercury is affected very much by changes of temperature. It is one of the most expansible metals; therefore if one barometer was read at a temperature of 80° and another at 32°, there would be a difference. Observations intended for scientific purposes should be reduced to 32° Fah. Then, again, there are barometers without moveable cisterns, or moveable scales; allowance then must be made for capacity. Also correction must be made for the action of capillarity. When a tube is plunged in water it has a tendency to draw a little into it. The tube appears to suck up the liquid to a certain extent. But when the tube is put in mercury, it presses it out. This is called capillary action, and an allowance must be made for it in barometers, because it has the effect of depressing the column of mercury.

The ordinary mode of fitting a barometer is by putting it in a wooden case. The French prefer this method, because they think it can be more securely fixed, is more portable, and less liable to be broken by a sudden concussion than if fitted in metal. The English opticians, on the other hand, think differently. They contend that the wood is liable to irregular expansion; that the tube cannot be so securely fixed in it; and that all things considered, brass is the best material.

We have before us a specimen of a brass tube for a marine barometer. It is called "The Kew Model Barometer," because it is the form which was approved by the Kew committee which sat some years ago to consider the state of the science of meteorology. Moreover it was recommended by the Congress of Brussels, held in 1853, with the view of promoting meteorological observations at sea, on a systematical plan. It is an instrument which has been extensively employed in the United States, by our own

government, and by private shipowners. Captains prefer it on account of its portability, the readiness with which it can be put up and taken down, and for its accuracy. It is an exceedingly accurate instrument. It can be adjusted to the $\frac{5}{100}$ part of an inch, and read to a thousandth. It can be set with great accuracy; for light is admissible to the top of the mercury by slits made in front and behind. Like almost all barometers it is read by means of a sliding vernier, moved along the scale by a rack and pinion motion. The lower part of the vernier is brought to the top of the mercury, so as just to shut out the light. No correction is required either for capacity or capillarity, it has simply an index error. The cistern not being adjustable, to do away with the correction for capacity, the inches of the scale instead of being true inches as usual, are shortened below the "neutral point" and lengthened above it in proportion to the diameter of the cistern to that of the tube. So accurately are they graduated, that, when compared with the Kew standard, the errors are determined to the thousandth part of an inch, and are very uniform and small. Mr. Adie invented this form of barometer and generously refused to patent it. In consequence they have been made in large numbers, and have been found of great utility on board ship, where they have preference to the wooden ones. I have known some of them to have been in use for five or six years uninjured, during which time they have been several times round the world. However, such is not always the case; in other hands they may be broken the first voyage. The durability of barometers very much depends upon the care of the persons who have their custody. Adie's may be sent with safety by railway: it can be packed very securely in a wooden box. With all its advantages, however, it has recently been superseded, to some extent, because it was found to require more care than could ordinarily be expected to be given to it by the commander of a ship. Seamen do not exactly understand the value of such nice accuracy as the thousandth part of an inch; but prefer an instrument that reads only to a hundredth part.

As regards the glass tube itself of barometers, an important modification has been used for some time,—by whom invented I know not. It is simply a "pipette," or small conical funnel, made in the inside of the tube, having its point downward. Its object is to arrest any air that may work in between the glass and the mercury. The bubble of air lodges at the shoulder and can go up no farther. It is one of those simple contrivances which turn out remarkably useful. If any air gets into the tube, it does not get to the top, and therefore does not vitiate the performance of the barometer.

It was advisable to construct a barometer as practically useful as possible for marine purposes. With that view Admiral Fitz Roy has contrived a barometer which can be set readily and read at a glance. That gentleman has given the following description of it in the "Ninth number of Meteorological Papers," published by the authority of the Board of Trade:—"This marine barometer, for Her Majesty's service, is adapted likewise to *general* purposes. It differs from barometers hitherto made in points of detail rather than in principle:—1. The glass tube is packed with vulcanized India-rubber, which checks vibration from concussion, but does not hold it rigidly, or prevent expansion." The outer cistern is made to screw on; by simply unscrewing, the barometer itself is got at. One advantage of the plan is that the captain has a spare tube. If he happens to break the one in use he can replace it by the other; but, as it is securely packed with India-rubber, there is very little liability of its being broken by fair usage. Every person who knows the importance of the barometer on board ship, will acknowledge that the supplementary tube is a decided improvement, which will generally be adopted when the plan becomes known. "2. It does not oscillate, or pump, though extremely sensitive." Its contracted tube prevents it doing so. "3. The scale is porcelain, *very legible*, and not liable to change." Instead of being, as ordinarily, made of ivory or metal, it is porcelain, and besides the divisions of the inches, it has words of universal application in the interpretation of the barometer movements, engraved as legibly as they are expressed succinctly; and of which I will speak of again. "4. There is no iron anywhere to rust." The supporting case is brass throughout, and all the fittings are brass, without any iron whatever; because the conjunction of the two metals produces a galvanic action which is objectionable. "5. Every part can be unscrewed, examined, or cleaned, by any careful person. 6. There is a *spare* tube fixed in a cistern, filled with mercury, and *marked* for adjustment in this or any similar instrument." The chief value of the contrivance is the ease with which a tube can be replaced when broken, all of them being made alike:—like rifle balls, all are of the same size. In fitting the spare tube, all that is necessary is to observe that a mark on the glass coincides with 27 inches on the scale.

"Although, for various reasons, these new barometers are graduated to hundredths *only*, they will be found accurate to *that* subdivision, the second decimal of an inch. They are packed with vulcanized India-rubber, in order that (by this and a peculiar strength of glass tube) guns may be fired near them without causing injury by ordinary concussion. It is hoped that all such instruments, for the Queen's service at sea, will be quite similar, so that *any* spare tube will fit *any* barometer." Many instruments of this description are afloat in the Royal Navy, and in a short time it may be expected that all the cases and tubes of barometers in the public service at sea will be similar in size and character; so that should a captain have the misfortune to get both his tubes broken, he would be able to borrow another from any ship he fell in with that had one to spare, which would be perfectly accurate, because it would have been verified before it was sent out.

On these new barometers appear strange words not resembling those upon ordinary instruments. The practice has been to place upon barometer scales such expressions as,—at 31 inches, "very dry"; 30·5, "settled fair"; 30, "fair"; 29·5, "changeable"; 29, "rain"; 28·5, "much rain"; and 28, "stormy." It requires no scientific knowledge to lead to the conclusion that these words are of little or no use. There was a storm lately with the glass at 29. There has been rain this month with the barometer not lower than 30. The whole of these words are nonsensical, because the barometer must of necessity vary in different localities. If a person happened to live several thousand feet above the sea level, on a mountain, the glass would never stand at 30 inches; and, consequently, according to the scale, he would never have fair weather. There is frequently quite different weather to that indicated by the scale, even at the sea-level, where the glass very seldom in this country gets down to 28 inches. These words have long been ridiculed by persons acquainted with the nature of the barometer fluctuations, nevertheless opticians continue to place them on the scales, evidently only because they appear to add to the importance of the instruments in the eyes of those who have not learned their inutility. Admiral Fitz Roy's great experience,—as an observer in all parts of the world, and as the chief of the Meteorological Department of the Board of Trade, where are collected registers of weather observations made in almost all parts of the oceans—combined with science, had led him to suggest a new system.

Before proceeding to consider the new system of words for barometer scales, I would ask attention to Professor Dove's law of the movements of the barometer with the gyration of the winds. Supposing a compass diagram, with the principal points laid down, the NE is the wind for which the barometer stands highest; for the SW wind it is lowest. This is found to be so in the great majority of cases; but there are exceptions to this, as to all rules. The NE and SW may therefore be regarded as the poles of the winds, being opposite each other. When the wind veers from the SW through W and N to NE the barometer gradually rises; on the contrary, when the wind veers from NE and E to SE, S and SW, the mercury falls. A similar curious law exists in relation to the veering of the wind and the action of the thermometer. Those who study barometers know that within the last three or four days the wind has veered completely round the compass, from N, through E, S and W to N; and that the barometer has been highest with N and NE winds, lowest with S and SW; but as regards the thermometer the NE wind brought the coldest weather, the SW the warmest. As the wind veers from the SW to W and N the thermometer falls; as it veers from NE to E and S it rises, because the wind gets from a colder to a warmer quarter.

It would occupy too much time to go into the philosophy of the action of the winds; those who wish to study it might consult, with much interest, a translation of Dove's work on the "Laws of Wind Gyration," by Admiral Fitz Roy. Suffice it to state that in the southern hemisphere similar laws prevail; but there the points of the compass are altered, because the cold winds come from the south, the warm from the north. The SE wind in the southern hemisphere corresponds with the NE in the northern. The rule there is, while the wind veers from SE, through E, N to NW the barometer falls and the thermometer rises. When the wind veers from NW through W and S to SE, the barometer rises, but the thermometer falls.

Admiral Fitz Roy caused a form of barometer, for the use of fishermen, to be constructed, the directions given in the scale of which are very practically useful, and are suited to the northern hemisphere generally, as well as around the British Isles. The scale words are as follows:—On one side, "RISE for north-easterly winds; that is for NW to N and E; *dry* or *less* wind:—Except wet from north-eastward." Underneath are the words

"Long foretold, long last,
Short notice, soon past."

On the other side the words are:—"FALL for south-westerly, that includes SE, S, and W; *wet* or *more* wind:—Except wet from north-eastward." The concluding words are:—

"First rise after low
Foretells stronger blow."

The exception in each case occurs with NE winds. The baromoter may fall with north-easterly winds, but then they will be very violent and accompanied with rain, hail, or snow; again, it may rise with these winds accompanied with rain, when they are light with not much rain; however it rises highest with the dry and light NE winds.

Such are the words on the scales of "Fishery" or "Coast" barometers. These instruments are very carefully constructed, and sent to various fishing places for the benefit of fishermen, in order that they may consult them before putting to sea. They are in use at forty or fifty fishing stations, placed there by the Board of Trade. The National Life Boat Institution has also sent similar to its stations. Their scale is not applicable for instruments intended for use all over the world, such as marine barometers. Admiral Fitz Roy, however, has arranged a suitable scale for them also. The scale for the northern hemisphere would be perfectly suitable for the southern, by simply changing the letters "N" into "S," or reading south for north, and vice versa. Then comparing and considering the words of the two scales it would be perceived that for all *cold* winds the barometer rises, and falls for *warm* winds. The mercury also falls for increased strength of wind, if it continues in the same quarter; it rises as the wind lulls. Likewise before or with rain the glass falls, and rises with fine dry weather.

Putting these facts together, and substituting for the points of the compass the terms "cold" and "warm," we readily understand Admiral Fitz Roy's scale on his marine barometer of which I have been speaking. It reads thus:—

RISE.	FALL
FOR	FOR
COLD	WARM
DRY	WET
OR	OR
LESS	MORE
WIND	WIND.
EXCEPT	EXCEPT
WET FROM	WET FROM
COLD SIDE.	COLD SIDE.

These scale words, then, are in perfect accordance to the laws deduced by Dové. There is nothing objectionable in them, and being founded upon experience, and the indications gathered from numerous records of the weather in all parts of the world, as well as confirmed by the deductions of science, may consequently be considered as generally reliable. They involve no conjecture, but express concisely scientific principles. These principles enabled Admiral Fitz Roy to foretell, a day or two beforehand, certain storms in the earlier part of this year. Government has carried out arrangements by which the state of the weather is telegraphed between London and the principal sea-ports. A system of signals is adopted, which gives warning to shipping, intimating the probable approach of dangerous winds and bad weather. So far as it has hitherto been carried out the plan has been quite successful, it appears. One of these intimations, in February last, was disregarded by a large fleet of colliers, and the consequence was that before morning more than half of them were wrecked.*

Some captains would prefer a barometer in navigation to a chronometer, so highly do they estimate its importance. Others complain of it because they do not understand its indications. When a navigator arrived in the vicinity of Cape Horn, his barometer became a source of great perplexity to him, unless he had studied its nature sufficiently. Those captains who had done so, found in that very locality, the barometer (so much complained of there) a most valuable instrument. It has saved many ships and lives, and hundreds of thousands of pounds worth of property. By its indications, properly interpreted, the careful mariner is warned, and is enabled to take in sail and prepare for the coming storm. Dr. Arnott, in his splendid work on physics, states that he was in a ship, the safety of which, and the preservation of the lives of all on board, he attributed entirely to the warning given by the barometer. It indicated an approaching typhoon; the captain accordingly took in sail, and he had scarcely done so when a most terrific gale came on, which, by the timely precautions taken, the ship was enabled to weather, and it could not have done so but for the barometer and the attention paid to it by the captain. The log of almost every ship tells a similar tale.

A very few words will suffice upon the *Aneroid*, it having lately been described in this Journal. It is now manufactured of very reduced dimensions, by Messrs Negretti & Zambra, and by a member of the Insti-

* Vide "Ninth number of Meteorological Papers."

tute, (Mr. Pitkin). In circumference, it is about the space of the bottom of an ordinary tumbler, and a little more than an inch thick, so that it is very portable, can be put in the pocket and carried about, hence will be very useful to fishermen, pilots, and travellers. The Aneroid before you is constructed by Messrs. Elliott Brothers. A description appeared in the "Mechanics Magazine" in May last. Its peculiarity lies in its case. It can be shut up and protected from wet or accident, being intended especially for travelling. There is a little hook by which it can be suspended in a room, like the ordinary aneroid. Its indications can be read off, whenever they are wanted, by a simple movement of the top. A moveable part forms an index, by which it can be set, and from which is ascertained whether it has risen or fallen. The aneroid is a substitute for the barometer. It has to be graduated and adjusted by reference to a standard barometer, therefore it cannot be regarded as an independent instrument; however, if set correctly, it is in every respect as good as a barometer for a length of time. The patent for the aneroid has expired, hence we might expect them to be manufactured at a lower price; but further improvements will doubtless be made in them, and so improved they cannot be sold cheaply for some time.

The *Atmoscope* will interest you, because it brings the horological art into use for barometrical purposes. It is a self-registering barometer, on the syphon principle, being the ordinary "weather glass," very carefully made, with a clock and registering mechanism attached to it; and is called by Admiral Fitz Roy, "the Atmoscope." At certain periods, some clock mechanism comes down on the point of the indicator, and causes it to mark a paper moved along past the indicator at a certain rate per hour. On the paper the time is shewn, as well as the height of the barometer. The instrument was first designed by Admiral Milne, and Admiral Fitz Roy writes of it thus:—"The atmoscope is found to be an exceedingly useful instrument. Its original design was invented by Admiral Milne, and though considerably modified since, as practice has suggested, in principle it is the same. It shows the alterations in tension, or the *pulsations*, so to speak, of atmosphere, on a large scale, by hourly marks, and the diagram expresses to a practised observer what the "indicator card" of a steam cylinder shows to a skilful engineer, or a stethoscope to a physician. It *may* be made to show its curve hourly, if required, by night and day for a week or more, but will be expensive proportionally to its subdivision and accuracy." The great value of this instrument is, that it will register for so long a time without attention.

Recently some very strange designs have been put forth for barometers. One is the invention of a gentleman named Mc Neild. It is constructed by Messrs. Negretti & Zambra. The tube is made to float on the mercury in the cistern. It is filled with mercury, inverted in the usual manner, then allowed to float, being held vertically by glass friction points or guides. By this contrivance the ordinary range of the barometer is greatly increased. One inch rise or fall in the standard barometer may be represented by two or three inches in this instrument, so that it shows small variations in atmospheric pressure very distinctly. As the mercury falls in the tube with a decrease of pressure, the surface of the mercury in the cistern rises, and the floating tube rises also, which causes an additional descent in the column. With an increase of pressure, some mercury will leave the cistern and rise in the tube, while the tube itself will fall, and so cause an additional ascent of mercury. Another design has been introduced by Mr. Howson, on a principle directly opposite to the one just described. The tube is fixed, but its cistern is sustained by the mere pressure of the atmosphere. Looking at the instrument, it seems a perfect marvel. It appears as though the cistern with the mercury in it must fall to the ground. The bore of the tube is wide, about an inch across. A long glass rod is fixed to the bottom of the glass cistern, where a piece of cork or some elastic substance is also placed. The tube is filled with mercury, the glass rod is plunged into the tube as it is held downwards, until it gets close up to the cork and fits tightly against it. The pressure against the cork simply prevents the mercury coming out while the instrument is being inverted. When it is inverted, the mercury partly falls, and forms an ordinary barometer column. When the top is held, the cistern and glass rod, instead of falling away, remain perfectly suspended. There is no material support to the cistern, only the tube is fixed, the cistern hangs on to it. Glass is a great many times lighter than mercury. When the glass rod is introduced it displaces an equal volume of mercury. The glass rod, being so much lighter than mercury, floats and sustains the additional weight of the cistern, by its buoyancy. In the meantime, the atmosphere is acting upon the mercury, keeping up the ordinary barometrical column. Supposing there is a rise in the ordinary barometer, the pressure of the

atmosphere drives some more mercury up the tube. This mercury is taken out of the cistern, which of course becomes lighter; when buoyancy carries it up a little higher, which also causes the column of mercury to rise still more. The increased pressure and buoyancy thus acting together, increase the ascent in the barometer column. One inch in the barometer might be represented by two or three inches in this instrument, according to construction. Supposing there was a decrease of pressure, the mercury would fall, come into the cistern, make it heavier, and increase the fall somewhat. Friction guides, at the top of the rod, prevent it coming into contact with the side of the tube when vertically suspended. These novelties have not been sufficiently tried to determine their practical value; but, as you have seen, they are far from the simplicity of the common barometer, therefore can never be so reliable, nor so accurately made.

In conclusion, let me add, there are various other improvements which might have been referred to. However I have brought under your notice the chief improvements effected upon the original mode of construction. Perhaps I may have given some information useful to some of the members of the Institute, because many persons engaged in the sale of horological instruments also sell meteorological instruments. Captains of ships generally expect to find that where they purchase a chronometer or send one to be rated, they should be able to get a good thermometer or barometer, aneroid, or sympiesometer. Although, therefore, members may not be engaged in the manufacture of them, it is well for them to be aware of the improvements introduced from time to time in their construction, principles, and mode of manufacture.

Mr. COLE, the chairman, in the name of the Institute, tendered the hearty thanks of its members to Mr. STRACHAN, for his able and valuable lecture.

BERTHOUD'S DESCRIPTION OF HIS MARINE TIME-KEEPER, No. 8.

TRANSLATED FROM HIS "TRAITE DES HOROLOGES MARINES."

Paris, 1773. *Chap.* x. *page* 271.

(*Continued from page* 35.)

Essential Remarks on the preceding Experiments.

After having put the oil to the escapement, the chronometer gained 7″$\frac{3}{4}$, now this effect is owing to the non-isochronism of the spiral, as the fifth experiment proves. For, if 10 degrees of difference in the arc have made the chronometer gain 2″$\frac{1}{2}$ in 24 hours with 12 ozs. added, 20 degrees of difference attained in the length of the arcs, after having put the oil to the escapement it ought to have caused by this same effect of the spiral a difference of 5″ in 24 hours. But since oil put to the escapement, has made the chronometer gain 7″$\frac{3}{4}$, in augmenting the arcs of 20 degrees; it therefore follows, that in taking away 5″ appertaining to the non-isochronism, the 2″$\frac{3}{4}$ which it has gained beyond this, belongs to the resistance or augmentation of the friction of the escapement, which happened since the departure of the chronometer. The third experiment serves also to prove my calculation, for, before the putting of the oil to the escapement, the addition of a weight of 2$\frac{1}{4}$ lbs. has augmented the arcs by 30 degrees, and the chronometer gained 8″ in 24 hours.

Second Remark.—The quantity of 12 ozs* added to the power, is equal to the difference which happened in the oil of the wheelwork, and the friction rollers.

Third Remark.—One can find a means of compensation, to the losing caused by the resistance of the oil of the escapement, and that very simply, by disposing the spiral so that the large arcs are slower than the small ones; whereas the spiral which has been employed during the trial rendered the large arcs quicker; we shall see the application hereafter.

Sixth Experiment:—The thermometer being at 14, the rack being at 12 degrees full, I advanced the index of the spiral stud to 14; in this case, the chronometer gained 4″ in 24 hours.

Seventh Experiment.—Having dismounted the escapement, to clean it, I set the balance going freely; its movement lasted an hour.

Eighth Experiment.—The escapement being cleaned, I set the chronometer going without putting any oil to the escapement; and then having set it going, I perceived but very little difference in the rate of the chronometer; it appeared that, without oil the arcs of vibration are larger, and that the

chronometer gains. I repeated often and during some time this experiment, and I found pretty nearly always the same results.

Ninth Experiment. — The wheels being cleaned, as well as the escapement, I put all these several pieces in their first state, new oil, &c. The arcs of vibration made 230 degrees; thus the difference of 10 degrees less belonging to the oil of the friction roller pivots; and perhaps a part of these 10 degrees belonged also to a slight augmentation in the friction of the wheel pivots; although I did not perceive any hole enlarged, nor any pivot marked.

Tenth Experiment.—Having set the movement going, out of its case, simply placed on a table, and then put it in its case, on its suspension, the chronometer gained more in the last case by 4″ in 24 hours. This gaining of the chronometer when it is on its suspension, belongs moreover to the non-isochronism of the spiral; because when the movement is placed on a table, the balance shakes by the vibrations of the movement of the chronometer, which diminishes them; whereas being solidly fixed, this action of the balance has less effect, and the vibrations are augmented.

Result, and Conclusion of the Experiments that we have described.

The losing of the Chronometer No. 8, was at Rochefort, 4″,12; and it became at the end of the trial 18″60, the difference, therefore is 14″,48.

These are the causes of the losing, and the quantity which belongs to each cause.

The oil put to the escapement has augmented the extent of the arcs 20 degrees, and the chronometer gained 7″$\frac{3}{4}$, but by these very exact experiments, which I have described above, 20 degrees of difference in the extent of the arcs, by the non-isochronism, made the chronometer gain 5″; these taken from 7″$\frac{3}{4}$ leave 2″$\frac{3}{4}$, the quantity which belongs to the alteration of the friction, or of resistance in the escapement; and for 30 degrees difference in the length of the arcs, the non-isochronism causes 7″$\frac{1}{2}$, add to that 2″$\frac{3}{4}$, we leave for these two causes of vibration, 9″$\frac{9}{10}$; then there remains 4″,58, the quantity which belongs to the alteration which has happened to the spiral stud mechanism.

Correction to be made to the Marine Chronometer No. 8, to give it the greatest perfection.

Of all the marine chronometers that I have constructed and executed, the most perfect without doubt is No. 8; nevertheless, in order that its correctness be the greatest possible, there remains many things to add, which we will point out; this will serve to give to marine chronometers the greatest justness.

We shall observe in the first place, that in order to lessen friction, whether at the pivots of the wheel-work or those of the friction rollers, oil must be employed; now oil as it thickens diminishes the extent of the arcs of vibration, and although the unequal arcs may be isochronous, the different resistances which the balance experiences will change the duration of the vibrations. It is therefore of the utmost importance to reduce the friction to the minutest quantity, and afterwards to make choice of an oil which for a long time retains the same fluidity; for it is well to be throughly impressed with this truth, as it is the most sure means of obtaining constantly isochronous vibrations, and preserving to the regulator the same extent in the arcs of vibrations.

To succeed in giving to the Chronometer No. 8, or any other machine of this kind, the greatest exactitude, you must employ absolutely an escapement which requires no oil,* and of which, consequently, the friction is the smallest possible; but it is at the same time necessary that the effects of this escapement be certain in all cases, and that it cannot disturb the nature of the free oscillations of the balance. We shall give in Chapter XII., an escapement which we hope unites these essential properties.†

Although I insist strongly that a marine chronometer should be so constructed and executed, that the arcs of vibration be exactly the same length, nevertheless to give a greater perfection to these machines, the unequal oscillations of the regulator must be of the same duration, that is to say, isochronous. But we have proved, by theory and by experience, that this property can be given by the spiral; it is therefore necessary

* But if in Chronometer No. 8, you would preserve the escapement, in perfecting nevertheless this machine, we can do it by a very simple way, which is to add a trigger, carrying a reservoir of oil, and by means of which the oil of the escapement will be renewed several times during a certain period. We ought to observe here, that the oil put to the escapement of a chronometer dries much quicker than the same oil put to the holes of the pivots, because in the escapement the oil is divided on all the teeth of the wheels and on the surface of the escapement, so that by the large surface which it presents, the air has much more hold; and if too much oil is put it is attracted elsewhere &c.

† Although by the eighth experiment it appears that in Chronometer No. 8 the escapement can be allowed to pass with advantage without oil, nevertheless I dared not send it to sea without putting some. I should be afraid that in the long run, the friction of the escapement would only cause an obstacle more dangerous still than the oil.

in consequence to correct the spiral of No. 8.

You must render the mechanism of compensation perfectly invariable; happily this is easy in that of No. 8. For this effect, you must fix the levers of compensation and of the spiral stud on their axles. When I took this chronometer to pieces, to clean all that belonged to the regulator, I found another cause of variation; it was, that the points of contact of the levers of compensation were marked, and there was around a red dust; but to avoid this effect, caused by the continued action of the spiral against the levers, you must put to the points of contact a little oil, and make these parts with good-tempered steel and very hard; and also give to the acting parts more surface, to the end that they have less wear.

To give more perfection to the chronometer, you must not neglect the suspension; that of No. 8 had many defects: 1st, it would not always take its exact position;* 2d, it would not permit a sufficient extent of arc of vibration, so this is what happened in going from Cadiz to L'Isle d'Aix, the ship was much agitated, the case was occasionally struck;† 3rd, the helical spring is not only useless, but is hurtful, because the suspension to permit its action ought to have play, which occasions a dangerous bounding in the agitations of the vessel. You must therefore correct, in consequence, the suspension, and especially render it perfectly solid and immoveable, and that it preserves always the same freedom. I ought to observe, it is very advantageous to have a long barrel loaded with a large weight; the chronometer by the vibrations, cannot move and it takes more surely its perpendicularity.

The Corrections that I have made to the Marine Chronometer No. 8. since its return, and before its second voyage, as ordered by the King.

The special trials that I have made with the Marine Chronometers Nos. 6 and 8, since their return in 1769, have served to estimate the causes which have produced the total error, and to distinguish the particular value of each cause; and it is after this examination, that I have established the corrections which were necessary to be made to these machines, to give them greater perfection. I occupied myself especially to rectify the Marine Chronometer No. 8, because I have always preferred this machine to No. 6, and conclude that it ought by its construction to give a greater degree of exactness. I ought the more especially to do so, independent of the love an artist ought to have to perfect his own works, to apply myself to rectify that which might be defective or imperfect in No. 8, seeing that I was then instructed of the intention that the Minister of the Marine had to make this chronometer serve for a new meditated expedition, and in which we were called upon to verify several methods proper to determine the longitude on the seas; and in consequence of the orders of the Minister of the Marine, I dispatched my Chronometer No. 8 to M. la Chevalier de Borda, on the 27th September, 1771, after I had made the corrections that I judged the most essential.

I am, however, still ignorant of what will be the result of my work, and whether it will add a new perfection to the Marine Chronometer No. 8. But I ought, whether or no, to render an account of them, for I dare believe that although the new work done to this machine, should not have all the effect and success that I had promised myself towards perfecting this machine, it will be nevertheless useful in general for perfecting marine chronometers, by presenting new views. It is for these reasons, that I am going to extract from my journal the most essential remarks and corrections, in order to complete that which concerns my Marine Chronometer No. 8; but I am not going to rectify the style of the journal. You must remember that my intention is rather to present to the public things which will be more useful than set phrases, which ought not to be required from an artist.

The most essential correction to be made to the Marine Chronometer No. 8, is to give to the spiral the property of being perfectly isochronous; but before altering it, it is necessary to examine if it is possible to be perfected. I therefore tried this spiral by lengthening and shortening it, in order to find if there were possibly any point therein in which it might be more isochronous, the large arcs being quicker than the small ones. To estimate exactly how much the spring was deficient in the suitable progression, I tried it on the elastic balance, fixing it on the same point where the spiral was really acting. After I had lengthened it the chronometer lost 2′ 15″ 15‴ in the long arcs, and lost 2′ 15″ 50‴ in the short ones, this spiral being mounted on its collet without straining it.

* It was a fault of execution, the pivots not being well turned.

† M. de Fleurieu has observed that the ship's rolling motion exceeds 45 degrees.

HOROLOGY IN CONNEXION WITH THE EXHIBITION OF 1862.

IT is with feelings of sadness that we approach the subject of the Industrial Exhibition, seeing that the heart-strings of the nation are wrung by the sudden loss of that good and able Prince who so well and so fitly took the lead in all national enterprises relating to Art and Science.

Before these remarks reach our readers, the allotment of space in the Great Exhibition of 1862 will have been made known to the Claimants in Class 15, and each exhibitor will have been made acquainted with the particulars necessary to enable him to make his final arrangements. There can be but little question, that, in so far as quality and intrinsic value are concerned, the forthcoming display will far exceed that of 1851; and in respect to our own department, we take this opportunity of urging upon the Horologists of Britain, the necessity of directing their attention especially to the quality, in respect of principles of construction, mechanical finish, and artistic beauty of ornamentation of the goods submitted by them to the public.

We venture to predict that success in 1862 will be more honourable, and probably more profitable than success in 1851; and therefore on private, as well as on public grounds, it behoves each one of us to exert ourselves.

In order to present something like a permanent record of the Exhibition, it is the intention of the Council to devote considerable space to the subject in the pages of their Journal; and as the fairest method of doing so is probably to allow each inventor or exhibitor to state his own case, they propose to insert full descriptions of articles exhibited, to be furnished by the owners. Should any engravings be necessary for illustration, they will be supplied by the exhibitor, or executed at his expense, the cost of paper, printing, and editing being borne by the Institute.

It is hoped that by this means, much that might otherwise be lost, will be preserved for future use, to the mutual advantage of individuals and of our profession generally.

THE BRITISH HOROLOGICAL INSTITUTE.

DISCUSSION ON THE BEST PRACTICAL MEANS OF IMPROVING THE CONDITION OF THE WATCH TRADE.

E. D. JOHNSON, Esq., V.P., in the Chair.

On the 13th November, Mr. GANNEY, read the following Paper, on the the above subject:—

MR. CHAIRMAN and GENTLEMEN,—No apology is needed for introducing the subject we have met to discuss this evening, though I should have preferred that some one more competent than myself, should have undertaken the opening of this question. The very anomalous position in which we find the watch trade, demands our earnest attention. It is anomalous when we know that the number of watches sold and worn in this country has been steadily increasing, whilst the number manufactured has been as surely decreasing during the last few years. In consenting to read a paper "On the best practical means of improving the condition of the Trade," I did not suppose I should be able to add to the amount of knowledge possessed by the members of this Institute, neither did I intend to bring to your notice any new or original plan for the speedy restoration of our horological manufactures to healthy activity; my more immediate object being to gather the opinions of the members of this Institute, on the possibility of securing for English horological productions a larger share of public patronage than they at present enjoyed. Taking a great interest in all that pertains to horology, I have viewed with sorrow and alarm, its gradual decline in the

land where the art has been fostered and brought to a state of perfection that has elicited the thanks and admiration of the whole civilised world.

In the present paper I shall endeavour to show you what I consider to be the causes of the present depression; and should they be (and I firmly believe they are) remediable, I trust the result of this discussion will be the practical application of the remedy.

In estimating the triumphs of the horological art, we may be excused the exhibition of an amount of pride and gratification, in reflecting that we have at the present time an Institution for the promotion of an art that has contributed so much to our national prosperity and greatness. The great reputation our horological productions have borne for accuracy, is undoubtedly owing to the efforts made a century ago to improve timekeepers, for the purpose of ascertaining the longitude at sea; it will not be necessary to particularise the various improvements adopted by men whose names are "familiar as household words" to horologists, a full account of which is to be found in the pages of the *Horological Journal*. Suffice it to notice, that though we have diminished the cost of accurate time-keepers, and as a necessary consequence increased the demand for them, yet we have done little to simplify the time-keeper or the means of manufacture, since Harrison in England, and Le Roy in France, astonished the world by the production of instruments that enabled the mariner to steer his precious freight with comparative ease and safety through the dangerous mazes of the mighty ocean.

The principal cause of the present depression in the trade, is the introduction into the British markets of Swiss watches in extraordinary numbers and variety, calculated to suit the taste and means of all classes of purchasers; and the dishonourable manner in which those productions have been disposed of as English goods, deserves our severest condemnation. When we find that more watches are imported into this country than we manufacture, the necessity of enquiring into this subject becomes very apparent.

The following statistics will show the great increase in the Swiss trade, and explain our own inactivity—In 1853, we imported 42,000; in 1854, 79,000; in 1855, it increased to 90,000; and at the present time, we are importing them at the rate of 160,000 per annum. During the month of September of the present year we imported 11,000.

The Board of Trade returns show that in the nine months of the present year, ending September 30th, the number of watches imported was 119,560, being an increase of 58 per cent on the corresponding nine months of the two previous years. There is undoubtedly a great demand for English watches; we have proof of it in the various schemes resorted to, to induce the public to purchase foreign productions; to such an extent has this system of marking foreign watches as the work of our own artisans increased of late, that the interests of all honest retailers and the trade in general demand that the strong arm of the law should be brought to bear upon those who do not scruple to increase their gains by such dishonest practices. We should meet this demand, not by reducing the quality of our own work, but by a reduction in the quantity; I shall make my meaning clear, by stating that the English watch movement is composed, when finished, of from 800 to 900 parts or pieces, necessitating some thousands of different operations,—whilst in the Swiss watch there are from 80 to 100 pieces only; viewed in this light, English watches are much cheaper than foreign goods.

The Swiss manufacture fifty years ago, was limited to a few thousands annually; it has now expanded to some millions, consequent on the low price at which a handsome time-keeper can be produced by them; this they accomplish by using a simple form of movement and escapement, and by a minute sub-division of labour. I am inclined to think their success is not so much owing to the cheapness of labour, as their adoption of the simple and very accurate cylinder-escapement invented by a celebrated English horologist, Graham. The question then resolves itself into this: can we supply a serviceable and saleable timekeeper at as low a price as our foreign competitors? I am certain we can; let any one who doubts this, compare the amount of work contained in our vertical watches that are finished at a few shillings, with the more elegant Swiss horizontal; in the one there are only a few wheels to pivot and run, while the mere enumeration of the work contained in our vertical watches would occupy the rest of the evening. The making of the horizontal escapement is a very simple affair, and could be done in less time than it takes to mount and pivot the scape-wheel and pallet-staff of the lever escapement; the horizontal escapement requires no pitching in the depth tool, the position of the scape holes being always the same, viz. half the diameter of the scape wheel distant from each other; add to its advantages of strength and cheapness, the peculiarity it possesses of performing well under disadvantages that would be fatal to any other escapement, and I think we have made out a good argument for its re-introduction into work; and though it may be argued the lever escapement can be made at a moderate price, and performs well with the going-barrel movement, yet with its intricate angles and delicate pitchings, we can never hope to attain that simplicity that characterizes the horizontal escapement. I am well aware of the necessity of maintaining a distinction between our own and foreign work, and this is the principal argument for the retention of the fuzee, though it is generally admitted that for ordinary purposes, the going-barrel gives results quite equal, and when a small watch is required, far superior to the fuzee; one objection to the English three-quarter plate going-barrel movement, is the difficulty of obtaining a sufficiently long winding square; this I have remedied by having the barrel arbor thinner, and the boss in the cover stouter and hollowed on the outside, and using the sunk stopping screwed in the ordinary manner to the upper plate; this obtains for the going-barrel all the advantages of the hollow fuzee.

The necessity of doing something to meet the great demand for a good watch at a low price, is evidenced by the fact that however excellent our productions, if we cannot supply them at a price

that will bring them within the reach of the mass of the people, we can never hope to obtain command of the world's market; we have proof of this in the destruction of the greater part of the English clock trade by the Americans. In France, American clocks are unknown, they being able to supply themselves with good clocks at moderate prices; we are also threatened with rivals in the staple of the English, the lever watch. Some of our skilful escapement makers have been exported to Geneva, to instruct their workmen in the lever escapement; others have been engaged by the American Watch Making Company, and unless we make an effort to improve our means of manufacture, we shall lose another large portion of our trade. We have now to take into our consideration the means to be employed to manufacture sound saleable watches at popular prices; the cooperative plan appears to be the best suited to accomplish our object, and the many hearty assurances of assistance which the advocacy of co-operation in the columns of our local press has elicited from London and provincial horologists, convinces me it is the best means of attaining our object, uniting the capitalist and workman in a bond of mutual interest and esteem. Funds would be raised in the manner so successfully carried out in other parts of the country, by co-operative associations, by £1 shares, payable by small instalments. Of course the method of manufacture and division of labour would be settled by the committee of management; no doubt the introduction of improved tools would meet with due attention. Such an association, if well managed, could not fail to improve the trade, and secure for the artisan a larger share of the blessings of life than he at present enjoys. Did time permit, I could tell you of surprising results attained by co-operation of workmen, who investing their few shillings in the business in which they are employed have become in a few years small capitalists.

I shall conclude, by quoting the language of Lord Brougham, who said, "That he knew of nothing so well calculated to improve and extend our manufactures, and, what was of more consequence, elevate the working man socially, mentally, and morally, as the simple plan of co-operation."

Mr. Bennett, after dwelling on the primary importance of this question, agreed with Mr. Ganney, and asked why we should not make the horizontal by the aid of every good tool, from any quarter obtainable. By this means, by a greater division of labour, the adoption of female labour, and the improved general education of practical men, he would advocate as a solution of the difficulty.

Mr. Styles was of opinion that there was more to be gained by the proper direction of labour than by any other means; there had been a great deal said of late on the introduction of machinery in watch-making; but he thought some of those persons could not be acquainted with the immense amount of machinery now in use: if they were to go to Prescot, into a movement-maker's shop, they would see that a great amount of the work was done by machinery; now the main question was to see what is done by machinery, and what might be done by labour properly directed; want of time would only allow him to touch on two subjects—the barrel and pendulum spring. Even in the improvements in the lever movements and pendulum springing there were defects, some of which he was endeavouring to remedy. The barrel-maker takes a lump of brass, chucks it on to his lathe, and the cutter being fixed so as to turn to the size he requires it, the barrel is turned complete in a few minutes; there is however a defect, which is found in all machinery of the kind; the cutter being made for heavy work, the corner becomes warm, and does not cut clean into the bottom of the rim: but that is remedied by the workmen by a hand-cutter; but for the want of a proper system, and of the proper size being laid down, there is perhaps more time lost afterwards than it took him to make the barrel-arbor and cover. The manufacturer in the first place takes off the cover, numbers the barrel, and sends the barrel to the spring maker; the manufacturer places it in the right box; the first thing the finisher does, is to look if the spring is too full in the barrel: he takes it out, breaks a bit off, winds it in, takes it out again, probably several times, till he gets it right; he will next look at the size of the barrel-arbor which he will find much too large; he will reduce that to the right size; in so doing he will have turned so much away that there is no hole left. Then he has to drill another in a tempered arbor; and if he is not an experienced hand, he will find it makes too few turns, and has to break it again. Now to meet this defect, the barrels and arbors should all be made to a gauge; the mainspring made so many inches long, and of a certain thickness, and if weighed, the weight will tell how many turns it will make; for springing, every day's practice shews that manufacturers should pay great attention to the size and weight of the balance; the finisher would thus be much assisted in springing the work; for instance: a finisher sent to my shop for one of Guye's pendulum-springs; he returned soon after for three more springs of exactly the same size and strength, as he had three more of the same sort of watches ready for springing. As the one sent went right for a time, the finisher imagined he would have no trouble in springing the others; but in this he was deceived: and what was the cause? they were all of different weights and sizes. If the balances had been all alike, that man would have saved probably a day's work, and the expense of a quantity of springs found on trial to be unsuitable; showing, that with balances of uniform diameter and weight, and with springs planted to the same size, any number of watches might have been sprung.

Mr. Cole concurred in the general bearing of Mr. Ganney's remarks, but not without some exceptions; he considered the barrel movement if made on the simplest plan, to be the least expensive, and was of opinion that a principle of escapement acting direct upon the balance in the manner of the horizontal, would also tend to lessen the trouble and cost of production; but objected to the horizontal on account of the difficulty of the wheel, and to the lever escapement on account of its complexity and numerous points of action requiring greater care, implying the use of some other principle of escapement more simple than the lever or horizontal.

He also stated that economy of manufacturing expense depended much on systematically working to fixed gauges, for giving exact dimensions *to all parts* of the watch in due proportion, as exemplified by the description given of a method adopted by him some years since. This consisted in a model movement, dial, and case, perfectly fitted and adapted to each other; these, when separate, admitted any number of dials and cases being made to the model movement, and any number of movements to the model case, all interchangeably fitting each other; the same rule applied to the main-spring, the balance, and balance-spring, as mentioned by Mr. Styles.

Mr. Bennett enquired if a finished movement could be made for a pound. Mr. Cole in reply said, by the employment of proper machinery, skilled labour, and capital, under the plan and system he had briefly alluded to, he believed it could be done.

Mr. Hislop was glad to find that the minds of many horologists were reverting to the horizontal principle as the simplest and soundest for cheap watches. They had heard from Mr. Cole, than whom no one was better qualified to give an opinion on the subject, that the lever escapement required a large amount of skill and good workmanship to produce it in perfection. He (Mr. H.) must not however be understood as approving of the Geneva watch as a model. The horizontal escapement was not a Swiss invention. It was an old English contrivance adopted by the Swiss as presenting facilities for production in large quantities at a cheap rate. He objected to the Swiss movement (in the skeleton form) as giving too great a number of parts, the balances as being generally too light, the stress on the pivots as being very unequal, and the suspended barrel as unsound. He conceived that it would be possible to arrange a new calliper for movements which should be almost entirely free from these defects, and which might be made soundly and well at a much lower rate than the cheapest English watches of the present day. With respect to the agency by which this change was to be introduced, he believed that it would best be done by a friendly combination. A watch-making company had been tried, and they knew the result. The principle of co-operation suggested by Mr. Ganney was open to grave objection; but he thought it possible to attain some approach to a decision by meetings like the present, and more especially if advantage could be taken of the forthcoming Exhibition to draw together something like a conference of horologists on the subject. He must however entirely repudiate the idea that the present depression in the watch trade was confined to England. They were as badly off, if not worse, in Switzerland as here. The markets were glutted with both Swiss and English watches; and what was needed was a revival of demand, which would doubtless be felt in both the great centres of the manufacture.

Mr. Mercer. As perhaps I am the only person present who has been a movement maker, I hope I shall be excused offering a few remarks. We are met to try to improve and facilitate our manufacture. Our only difference is, how we can do it. The question seems to me to be in very narrow limits, for we at most can only expect from the workman an improvement in the details of his particular branch; and I attribute all our shortcomings to the fact, that our manufacturers, present and past, do not occupy the position they should; we see them more as vendors or dealers anxious to make up and supply goods, but not, as far as I am aware, employing their talents and capital to facilitate the production of the goods themselves. As a consequence, we have routine, want of method,—the parts not collected in the best form, for want of a directing head.

A great many or all these evils I believe are of easy remedy, without, to a great extent, destroying our present trade arrangements, if our manufacturers would do as engineers or architects do before they commence,—map out a plan, and arrange every detail to given sizes, in no case letting men work by judgment, always to scale; making decimal sizeing and the duplicate system the base to work from.

In Lancashire, with tools and engines, they have ample means to carry out this system; they can make parts quite as cheap as the Swiss. Their movements have on them a deal of labour, but not in the shape it should be; they are made to sell as complete articles, not as incomplete work, and are finished accordingly.

If instead of movements, parts were collected in as far as possible a complete form; frames made to a calliper with the movement holes, motion, dial feet, &c. in it, the train holes being left undrilled, —we should, by making springs, dials, &c. to a duplicate, have all ready to screw on at once; the frame maker getting notches cut for bolts, joints, &c., in an engine when the plates were in the rough, if these were needed; the plates made to size for case; and to this the cap could be added. If this were done, and the barrel, &c. done as recommended by Mr. Styles, the fuzee would be just as easily made and cut at once complete as it now is done; the pinions, motions, &c. might be done in quantity to gauge, the wheels being cut in a like manner. By simply supplying the finisher with a calliper to use, he could drill off the depths from it; and this would leave him little more to do than plant the stud. System, and production in great quantities, constituted the secret of Swiss success; and by system, America hopes to supersede our trade; but if we can get in the wedge, in whole or part, towards improvement, we may count on future success.

Simpler movements might be of use, and possibly other escapements cheaper; but this is by no means certain, and the difference in price would be a trifle; but improved systems are applicable to all kinds, and we have at once means at hand to improve,—not staying for "educational improvements," for if they are needed it is only in the "staff" who direct; for I am sure the education from a good drill-sergeant will alone be quite sufficient to whip up English workmen to any standard of excellence.

Mr. Tilling.—Mr. Chairman: I am surprised to hear the horizontal escapement and going-barrel advocated by gentlemen from whom we might expect staunch support of the English watch; an advocacy contrary to all modern experience, and opposed to the judgment of our forefathers, who rejected it for the lever, as a principle which possessed—as compared with the cylinder—admirable timekeep-

ing qualities, even in the early imperfect state in which it was made. Must we, because the Swiss have succeeded in establishing a large trade in one branch of manufacture, abandon a principle that has brought so much honour to the horologists of this country, with the dreary idea of competing with them in price? There is no disguising the fact, we cannot make imitation Swiss watches in London as cheap as they can in Switzerland, any more than the Swiss can make English levers as cheap or as good as we can, though they try to accomplish the feat. Did any of you present ever meet with a Swiss going-barrel lever that was a perfect timekeeper? I never did; it is not in their nature to be accurate unless made so by isochronism, which is no element of cheapness, and which can only be applied to first-class watches; for not a hundred in the entire trade can adjust a pendulum spring; while there is scarcely a watchmaker in existence that cannot adjust a fusee And a detached escapement, whether chronometer or lever, must have an adjustment at one end of the train to be a timekeeper; and certainly the fusee is the cheapest of the two, and quite as eligible for cheapness as the going-barrel with the English workman, and perhaps more so; if then we must make low-priced watches, let them possess those distinctive English features, the fusee and lever escapement. But is it desirable to do so? what has Coventry gained by making low-priced watches, but sunk their name the lowest in the kingdom. Had they made good watches, however plain, the name of Coventry would have been a credit to a watch, instead of the disgrace it is, and their factory system would have contributed to the cheapness so desirable; and with the movements made more in accordance with the wants of the manufacturer to standard sizes and a recognized measurement applicable to every branch, would prevent those repetitions of work we are now subject to.

At each period of depression, we are told the trade is leaving us, and the foreigner is getting it. But is it so? The fact is, the Swiss are suffering as much, if not more, than we are. Though there are great numbers in London with little or nothing to do, we have no public parade of their wants; their sufferings are relieved or hid, by the mass of population who, more fortunate, are not connected with the watch trade. But it is not so in Switzerland, where in those parts the inhabitants are principally watch makers, the panic is a public spectacle visible to all who are willing to see; one manufacturer alone in Geneva having three hundred watchmakers and jewellers working on the fortifications, as labourers, at the date of Mr. Ganney's letter. When he stated there was unprecedented activity in Geneva,—did he mean with the pick and spade? Now if one manufacturer could have 300 out, how many must be out altogether? Yet Geneva is less affected by depression or fluctuations of trade than any district of Switzerland,—so much for the comparative depression of both countries.

It is considered surprising that in this country, possessing the manufacturing and mercantile capacity it does, our trade does not attain the magnitude of other manufactures, or of watchmaking in Switzerland. But there are no means taken to augment its growth; we must consider that watch-making with us is only one of our many industrial pursuits, having but little capital invested in it to impel the manufacturers to produce at risk as in many other industries. Take the cotton trade, with its 100 millions invested in machinery and other appliances, the mill-owner is obliged to keep producing as long as he can to prevent his own ruin. While the Swiss watchmaking is what cotton is to Manchester, their principal dependence; consequently in times of depression, all classes support it, and large sums are invested in the hands of the manufacturer to increase production; even the savings of the workmen, that with us go into the savings bank or building society, there remain in the hands of the employer to swell the manufacturing capital; for stoppage is as disastrous to them as to the cotton operative; the consequence is, great numbers of watches are always being made and forced on the markets of the world, absorbing the trading capital whether they have orders or not. But with us it is quite the reverse; if there is depression of trade our manufacturers execute orders only, with few exceptions; and as their capital becomes disengaged they invest it in anything that is safe in preference to watches;—it is the last thing thought of to increase production by increased investment. Mr. Ganney's co-operation of labour and savings, as a cure for the ills that beset us, though certain to make the workmen their own employers ultimately, would be of such slow growth it would not be available for present improvement; but co-operation of masters and money would no doubt increase production to a great extent by the increase of capital it would bring into the trade, as a permanent investment. Mr. Bennett, while advocating the Swiss watch as our model, tells us we have had no improvement in the chronometer for 50 years, or in the lever for 30 years, and we could get a first-class watch as good then as we could to-day.

Chronometer makers may answer for themselves; but as a lever-escapement maker I cannot hear such a statement, without contradicting it. Within 30 years, the lever has been at a very low ebb, and the principle so little known, that but for George Savage it would possibly by this time be numbered with the verge as a by-gone principle; but he evidently appreciated its capabilities, and convinced the trade there was an element of superiority in it that only wanted developing to vie with the chronometer and duplex as a pocket timekeeper; his production of the two-pin lever was a masterpiece of ingenuity, it was superior to anything that had preceeded it in timing capabilities; few persons imagined what the lever could do until he taught them with the beautiful specimens he produced; he improved the pallet; and though the short-angle principle was not considered essential by him, Savage's lever is calculated to produce that element by the arrangement of the impulse notch, resembling the chronometer by exerting the impulse at a greater distance from the centre of the balance than the discharge of the locking of the wheel; the superior timing, with the lightness of action and freedom from set of the two-pin lever, gave an impetus to improvement and invention that has brought it to its present state of excellence in

endeavouring to retain the principle, without its delicacy; and all real improvements possess the elements of Savage's lever; among them we find the jewelled two-pin lever, the solid impulse lever, the double-roller, resillient, repellant, and many other minor productions and readoptions that diversify the lever escapement, until it is now unquestionably the best pocket time-keeper, and all those improvements have been produced within 30 years! Yet Mr. Bennett asserts we have had no improvement within that period.

(To be Continued.)

LECTURES ON MECHANICS,

In course of delivery, at the BRITISH HOROLOGICAL INSTITUTE.

BY W. HISLOP, ESQ., F.R.A.S., HON. SEC.

LECTURE I.

Introduction.—Properties of Matter.

Before entering on the more immediate subject of my lecture, it will be desirable to point out the course I propose to take, and the objects I shall endeavour to attain. I may first observe, then, that I intend to begin at the beginning. We may be quite sure that knowledge is worthless that is not firmly and correctly based; therefore the present lecture will be devoted to the properties of matter, as introductory to the laws of matter. In respect to the relation of mechanics, as a science, to our own particular art, it would be impossible to overrate a knowledge of it to us as individuals. It is true, indeed, that it may not enable us to do our pivoting with greater ease, or to polish our arbors with a better gloss, but it will most assuredly enable us to understand and give a better reason for the details of construction with which we have to do. In this way it may often save us a great deal of unnecessary labour, while it will, by educating our constructive powers, enable us to arrive at results to which others have not attained by the readiest means. I have known first-rate workmen utterly at fault in the theory of their profession; faultless in all the practical details which they undertook, they yet only followed a certain course because others had followed it, or because they had tried it, but without any sound theoretical reason for it. I have found among these persons a feeling about a watch or clock as though it were a sort of natural production, incapable of any important variation in construction. To illustrate my meaning, I knew a very excellent duplex escapement maker, who had got the notion that a duplex escapement must necessarily make 150 beats in a minute to go to time. I was then a lad, and he got quite angry with me for endeavouring to make a duplex watch beat 120 times in a minute, or half seconds. He said it could not be done. I in vain explained that the train was altered, and that if the watch was sprung to ordinary duplex time it must gain. He was quite disgusted, and left me to go on in my own way. Now, this man failed in his power of combination: he was unable to view the escapement in a fresh relation to an altered train, although the same man, if set to spring a lever watch, knowing that they were made with different trains, would first have counted the train, and sprung his watch accordingly.

In entering upon the consideration of the Science of Mechanics, it may be necessary to clear the way beforehand by defining the objects comprehended in that department of knowledge, and the results sought to be attained by their investigation. There is no branch of science to which Mechanics will yield in importance; in fact, it may be said to lie at the basis of the whole superstructure. No one that is not well grounded in knowledge of its laws can ever excel, or even attain a mediocrity, in any branch of natural philosophy. For this reason it is generally made to form a prominent feature in a course of university study, although, unfortunately, the manner in which it is treated is far too theoretical to be of much real use. As well might we endeavour to buy and sell by the aid of algebra, as to bring into practical use and experience practical benefit from the course of study which is usually followed in our colleges. Let us hope that the day is not far distant when the mind shall not be encumbered by a mass of generalizations to be found only in dusty folios, and of no conceivable use except to disgust the student and drive him from the pursuit of science; but when natural philosophy will have taken its true place, and the lover of knowledge shall be able in his studies to combine theory with practice, so that the one may correct and establish the other. It will be my endeavour in these lectures to demonstrate the laws of which I shall have to speak by reference to well-known facts, and (as far as our somewhat straightened means will allow) also by the aid of experiments and diagrams. As an instance of the importance of our subject, I need but allude to the fact that those wondrous astronomical phenomena which are comprehended in the motions of the heavenly bodies are governed by, and therefore can only be understood by a knowledge of the Laws of Mechanics. Several of my illustrations will therefore be drawn from the science of astronomy. The laws we shall have to consider likewise comprehend the most ordinary phenomena; thus, we cannot lift a chair or walk across a room, without acting in accordance with certain established principles, with which if we are acquainted we may facilitate our locomotion,

lighten our labour, and in fact be able to produce the greatest amount of effect with the least possible waste of energy.

Knowledge may be divided into three great classes. These are,—the Science of Matter, or Natural Philosophy; the Science of Life, or Physiology; and the science of Mind, which is Mental Philosophy. The first, or Natural Philosophy is again divided into Chemistry, and Mechanical Philosophy.

Chemistry treats of those elementary substances which constitute compound bodies, and illustrates the laws of combination; while Natural or Mechanical Philosophy includes machinery, and may be studied to advantage in the vast operations of nature. There cannot be a practical result without a fundamental principle. Mechanical powers, pointed out and demonstrated by Archimedes, are the foundation of all the complicated machinery of our factories. By Mechanical Science, we convert wool, cotton, and flax into materials for clothing: and from Chemistry we obtain the dyes and other substances necessary to ornament them. While Chemistry, therefore, relates to those changes in natural bodies which are not accompanied by sensible motion, and determines the ultimate constitution of bodies, and the properties of their ultimate materials, Mechanical Philosophy relates to masses, calculates distances, and takes cognizance of those physical actions which produce no real change within the bodies operated on. Chemical changes, however, are often followed or accompanied by physicial effects, as in our various means of illumination; also in the case of gunpowder, likewise in the steam engine, and in the familiar instance of the soda-water bottle.

I shall now proceed to define certain properties of matter, in so far as they are connected with my subject. Matter is that which, under various forms, affects the senses. It possesses certain attributes which excite in our minds certain sensations, and the powers to excite these sensations are called properties. To ascertain these properties and classify them is to become a Natural Philosopher. This takes place the moment we begin to feel and perceive, and reason upon our feelings and perceptions. The term "Natural Philosophy" may frighten some minds when seen on the title-page of a book or the door of a class-room, but it is, in fact, the pursuit of every one possessing the faculty of reason.

A large number of the properties of bodies may be called peculiar, because found in some bodies and not in others; thus the loadstone has the property of attracting iron; the effect of a black colour belongs to one body, that of a red to another, and the like. There are properties, however, which are inseparable from matter, in whatever state or whatever form it may exist. These are tests of materiality, and where their presence cannot be proved, matter cannot be.

The first property to which I shall allude is *Extension or Magnitude*. Every body must occupy a certain amount of space; in other words, it must have magnitude. We cannot conceive of a body so small as as to occupy no space whatever. The terms volume or size have the same signification; thus we speak of the magnitude of the earth being equal to so many cubic miles, the size of a ball to so many cubic inches, the volume of air in this room as occupying so many cubic feet. The proportion of the quantity of matter to the magnitude is called density, and is proportionate to the closeness or proximity of the particles to each other; thus, a certain bulk of lead is 40 times heavier than the same bulk of cork; mercury is 14 times heavier or more dense than water; and water, again, is more dense than air.

Impenetrability. A substance would be penetrable if it would allow another body to pass through the space which it occupies without disturbing its component parts. There are many instances of apparent penetration, but in all these the parts of the body which appear to be penetrated are only displaced; take, for instance, a nail driven into wood—if the wood be opened, it would be found that its particles around the nail are forced aside into closer combination with each other. In the case of liquids, if I dip my hand into a vessel of water, the water rises; a bulk equal to the volume inserted being displaced. Air and gases are also impenetrable. If I dip an inverted jar into a vessel of water, the water refuses to rise within it. Now if the jar had been void of matter, like the space above the mercury within a barometer tube, nothing would have prevented its being filled with the water.

Another property is *Divisibility*. Although matter is impenetrable, it is separable; if it were not for this property nails could not be driven into wood. Every known body can be divided into parts. No practical limit has been found to this separation; but still it is highly probable that all bodies are composed of parts which are indivisible and unalterable. These parts are called ultimate atoms, and are so minute as altogether to elude the senses, even when assisted by the most powerful aids. The word "molecule" is often used to signify component parts of a body so small as to escape sensible observation, but not ultimate atoms—arranged according to some determinate figure, as in the various kinds of crystalline formations. The term "particle" is used to express small component parts, but not so small as to elude observation.

I have stated that no practical limit is known to the divisibility of matter. Dr. Wollaston succeeded in obtaining platinum wire only 1-1800th of an inch in diameter. The smallest spherical object visible to a good eye is the 1-2000th of an inch in diameter. By the assistance of a microscope, we may distinguish a body a hundredth part as large, or 1-200,000th of an inch in diameter. The thickness of gold-leaf is less than this, and the gilding on lace still thinner, probably not above 1-10,000,000th of an inch: so that 1-2000th of a grain would cover one inch, and a portion just large enough to be visible by a microscope would weigh only the 1-80,000,000th of a grain. A grain of musk is said to be divisible into 3200 quadrillions of parts, each of which is capable of affecting the olfactory nerves. Newton determined the thickness of laminæ of transparent substances by observing the colours which they reflect. A soap bubble, for instance, is a thin shell of water, and is observed to reflect different colours from different parts of its surface; just

before the bubble bursts, a black spot may be seen near the top; at this part the thickness has been found not to exceed the 1-2,500,000th of an inch.

In organized nature the instances are still more remarkable. The transparent wings of certain insects are so attenuated in their structure, that 50,000 of them placed over each other would not form a pile a quarter of an inch in height. Dr. Arnott states that two drachms of the ordinary spider's web would reach from London to Edinburgh, a distance of 400 miles. The blood which flows in the veins of animals is not a uniform red fluid, but consists of minute red globules, floating in a transparent fluid called serum. In different species these globules vary in figure and magnitude. In man and all other mammalia they are perfectly round or spherical. In birds or fishes they are of an oblong or spheroidal form. In the human species their diameter is 1-4000th of an inch, so that in a drop of blood which wonld remain suspended from the point of a needle, there must be about a million of globules. Each of these globules again, is a gelatinous mass composed of many atoms. Now, minute as these bodies are, the animal kingdom presents us with beings whose whole bodies are still more minute. Animalcules have been discovered so small, that a million of them would not exceed in bulk a grain of sand; indeed, it has been discovered by Ehrenberg that a single cubic inch of the polishing slate of Bilin (our common blue stone) contains 187,000,000 distinct organisms. These animals have the same properties and propensities as those of a larger size. They feed on various substances, and also on each other, and digest their food. They are provided with limbs perfectly articulated, and perform their various functions in as perfect a manner as larger animals. It follows, then, that they must possess the various details of parts necessary for the performance of these functions; and if so, how inconceivably minute must these parts be. If a globule of their blood or other circulatory fluid bears the same proportion to their bulk that a globule of our blood bears to our magnitude, what powers of calculation or analysis would give an adequate idea of its minuteness?

(*To be continued.*)

ON THE PENDULUM.

Second Lecture.

Delivered by E. D. JOHNSON, ESQ., F.R.A.S., *for the* HOROLOGICAL INSTITUTE, *at* SPA-FIELDS LECTURE HALL, *October 16th*, 1861.

MR. KLAFTENBERGER, V.P., IN THE CHAIR.

(*Continued from page* 42.)

We now come to apply these principles to practice, and it will be seen that they are of primary importance. A great number of tables have been constructed upon the subject, but one little form of table, and the way to use it, will supply all the information that a practical clockmaker will have to deal with in regard to the length of pendulums.

In the remarks I am now about to make, I shall always speak of simple, and not of compound pendulums. The whole of the weight is in the bob; the weight of the string amounts to nothing. A simple pendulum of one inch will vibrate 375 times in the minute. If therefore you divide the number 375 by the number of beats you desire the pendulum to make, the quotient so found will be the square root of the simple pendulum you require. This multiplied into itself gives the length sought. Nothing is more easy than to avoid the necessity of going to the converse proposition, or turning back again to the length of the pendulum, seeking how many vibrations it will describe, that would involve the extraction of the square root. But this table (pointing to a short and ready calculation) is of a more simple construction. Most of the pendulums put up in workshops, for instance, are such as these. You can have by ten minutes computation, all you want. Then, with a pin, you can prick out any pendulum you require from such a little list. (Illustrating on a black board.)

By constructing such a table, you will possess that which will suffice for all purposes, and enable you to carry on the proposition any length you please. So much for the subject of mere calculation.

But there is one application which is of far greater importance. The time of the pendulum, as I said, is determined by the length of the radius; in fact, by the size of the circle which the pendulum describes. This leads us to be certain, as far as we can, that nothing either alters the distance between the centre of suspension and oscillation, or affects those positions by any other relative cause.

Now with regard to the point of suspension. There is an absolute necessity for having it firm; because here, although we look upon a pendulum rod as a force, to convert what would otherwise be a vertical force into a large horizontal motion combined with it; we must here change our ideas, and look upon it as a motive power, the pressure being exerted by the swinging weight. This has an influence to pull upon the point of suspension, because in proportion to the mass there is an alterna-

ting pull on that point. Thus, if you draw a line, as I have described here to illustrate the position, you will see it. There is one mode, as explained, of altering the time thus, by altering the angle. The measure of the force being expended, any alteration in this point horizontally subtends directly some very different angle. If there is any horizontal motion capable of being set up, the point of suspension not being fixed, the weight will pull it aside, and you will get the angle representing a much larger pendulum. Hence any amount of unsteadiness, at the point of suspension will make the pendulum lose; if on the other hand, the point of suspension be made more steady than before, the pendulum directly tells you the result by gaining. The measure of the effect produced will appear by the very small horizontal line drawn thus between the vertical line and the rod at an inch distance from the point of suspension, a small alteration in which subtends a large increase or decrease in length, in the angle or rod, as the case may be. A clear approximation is made to the lines, showing the angles consequent on the amount of motion placed as it is immediately at the point of suspension. The least amount of motion sideways immediately subtends a very much longer rod, inasmuch as it directly alters the angle formed here. Suppose the angle formed at the vertical pull of the line of the pendulum, if you move to the right you now obtain a more obtuse one, and so on until no motion takes place at all. But the want of steadiness at the point of suspension, will not only make the pendulum lose, because it subtends a larger one, but is fraught with a thousand irregularities.

The next difficulty touching the length of the pendulum, is one with which we have had to contend, as horologists, from the commencement of anything like scientific time-measuring. We have the difficulty of the expansion of the materials of which pendulums necessarily must be made. All the materials with which we are acquainted—at any rate all that we have employed in the construction of pendulums—I need not tell you are dilatible by heat and contractible by cold. There are a vast number of tables constructed on experiments with the pyrometer, an intrument for measuring these expansibilities, but I cannot say with as good results as might have been deemed desirable. I cannot tell you the enormous variety of contrivances which have been devised by ingenious men for remedying this prime difficulty.

I have some of them on the wall here. This represents a plain pendulum—a simple rod or bar, and lenticular bob. This shows the same thing edgeways, all the others are compensation pendulums. But, as I said before, it is almost impossible to calculate the enormous variety of compensations which have been devised; and for that reason I have been obliged to collect a few of the typical ones. Each of these has an enormous variety of forms, but this will represent a striking feature in the compensations of pendulums devised for the purpose of keeping the two centres, the point of suspension and the centre of oscillation at exactly one constant distance. The first means devised was of a very natural, and as one might expect, of a very rude character. Suppose this (on black board) to represent the suspension cock of the pendulum, and this the pendulum spring, the spring passing through it. Imagine this spring fastened to a lever joined on to the back of the case at the point near the cock of suspension; and then imagine a bar abutting against some portion of the underside of that lever, and carried down the case, and attached to a bracket, and of course expanding upwards. You see that the further from the centre of motion, the smaller the power of the lever to draw the spring up through the slit in the cock and to shorten the pendulum, and vice versa.

This was very well to make a beginning with, but it was attended with a good many practical drawbacks. Moreover, no approach to a thoroughly good compensation pendulum until this (the gridiron) was devised by Harrison. This is called "the Gridiron Pendulum," simply because its rods resembled the bars of a gridiron as they are arranged in parallel lines. It is designed for the purpose of applying the upward extension of a larger expanding material to counteract the effect of the elongation downard of a less expansible material.

This is a pendulum in which all the steel bars are suspended to cross pieces at the top, and expanding downard, the bars balancing each other in pairs. The object is to enable the maker to get the final rod in the centre. The centre rod is the fixed one that carries the bob. In this case the adjustment is first of all calculated as near as may be, and is finally corrected by shifting the weight—this cross-piece which is left out designedly here. This shews well the principle of employing a metal having a large ratio of expansion to counteract the elongation downward of a rod of metal of a lower degree of expansion. Here you perceive in these rods all the brass expands upward and all the steel downward. The superior expansion of the brass enabling a smaller quantity to do the work, and keep the centres of suspension and oscillation at the same constant distance apart. The means of adjusting the compensation of this pendulum is by cross pieces of metal pinned to the rods and capable of shifting up and down as experiment directs. They have been left out of the diagram designedly to avoid the appearance of confusion.

I said that I considered these as typical. I have a pendulum constructed exactly on the same idea, but the simplicity of its parts so facilitates its execution that it is well worth contemplating. It is exactly the gridiron pendulum in the tubular form, and is known as "Troughton's Tubular Pendulum." It is composed of two brass tubes and five steel wires, the tubes having caps at top and bottom forming abutments below, and points of suspension above, which will be understood by observing the several dotted circles here represented (alluding to the diagram) which show the position of the wires as they pass through the covers top and bottom of the inner tube. The bob of the ordinary lenticular form being finally suspended by its centre to the last pair of wires. That pendulum is so easily executed, that I have myself made it at a watch-maker's bench. There

is a fault in this pendulum of some consequence, namely, the difficulty of providing for final adjustments such as I before recommended. Although a supplementary weight might be slid on the rod for that purpose; and in constructing such a pendulum I myself received a lesson which caused me to caution you as I did against too implicit reliance upon tables. The instance I allude to being so great a permanent expansion of such a pendulum rod by the heat in the final process of bronzing that I could not put it together, and had to turn the fittings in the lathe.

The next type of pendulum, is the mercurial in which the compensating body forms the bob of the pendulum by its mass. This has a good number of imitations, one of which I have here delineated. The bob is of the tubular form, and is calculated by its extension to compensate a wooden rod; but such a pendulum is necessarily longer on account of the inferior specific gravity as compared with mercury. The reason why the mercurial has become the very leading form of pendulum, is the amazing simplicity of its final adjustment, it being only necessary to increase or diminish the compensation, to add to or subtract from the quantity of mercury.

This (referring to diagram) is known as the Ellicott. It is a type of pendulum very ingenious, and apparently very adjustable, but against which I have to caution you. It is composed of a flat iron or steel rod, with a flat brass rod lying simply against it, abutting against a shoulder projecting from the steel rod at its upper end, and expanding consequently downwards. The end of this brass bar presses on the short arms of two stout levers, turning on centres fixed in the end of the iron bar, and supporting the bob by their long arms, raising the bob or letting it down according to the motion given by the expanding brass rod on them as before stated. The adjustment of this pendulum is effected by screws, which shift the point on the levers on which the bob rests. I have now to give you the caution I referred to: this pendulum, and all such as act mechanically, change by jumps; this spring (alluding to the pendulum) was designed to obviate this defect, but it does so very imperfectly.

This is a diagram of Ward's Pendulum, a very good one, and comparatively free from most objections. It is not extensively used, but I can scarcely tell why. It consists of two iron rods having between them a flat bar of the compensating material fastened together by screws, cut top and bottom only. And the quantity of the compensating material in action is determined by the position of those screws, many holes being provided for their arrangement.

There is another description, called "Biot's"—but the inventor's name was Martin, which Biot himself acknowledges. This is a plain pendulum, with an iron rod and an ordinary bob; a cross piece, being a compound bar of brass and steel—the brass being on the underside, and securely fastened to the upper side (steel) by brazing or soldering—the whole sliding up and down the rod by means of a short piece of tube attached to its centre, fastening by a screw to the rod. This bar curves by increase of temperature, in consequence of the greater expansibility of its under side. Weights are slid on either arm of this bar, and fixed by thumb-screws at that point where they are found to do the exact quantity of compensation required, and indicated by experiment. This, the last pendulum which I shall describe to you, contains the greatest interest of all, because it shows how necessary it is for us to ascertain what has been done before by others. I am not aware whether such a pendulum ever was constructed; and this diagram, which was kindly sent by Mr. Woodcroft of the Great Seal Patent Office, is the design of an amateur, and was merely brought here to show how complete a bad imitation of the Ellicott might suggest itself, and so lead to the construction (as a novelty) of what others had tried and abandoned. It is here proposed to make a pendulum rod of slate, having a cross piece at its end, all in one, to carry bent levers turning on pivots—the long arms to carry the bob, and the short ones to be moved by the expansion of some material abutting against them; the arrangement and proportions being far inferior to Ellicott's.

(To be Continued.)

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

(Continued from page 25.)

1846, October 22.—No. 11,427.

HUTTON, John. — 1. The employment of an auxiliary compensation on the principle of diminishing and increasing the resistance of the atmosphere to the motion of the balance in proportion as the temperature rises or falls. To the fixed end of a metallic thermometer, a light cap or lid, which nearly surrounds the balance, is attached by two arms made thin in one part. When the temperature rises, the free end of the thermometer expands with it, and a ruby, coming in contact with a regulating screw, raises the cap from the balance, which gives more freedom to the air around it, and diminishes the resistance to the motion of the balance; when the temperature falls the free end of the thermometer contracts, and another ruby acts on the regulating screw and produces the contrary effect, whereby the resistance to the motion of the balance is increased.

2. The application of a barometer, the rising and falling of the mercury in which, serves as a motive power to enlarge or contract the air space of the pendulum. The clock has a barometric tube fixed to one side of the case, in which is a piston or float with a light rod attached. An air resister, consisting of a plane surface, is suspended by spring rods from a bracket in the back of the case; on the top of the plate of this resister an inclined plane of an angular shape is fixed; this projects over the piston rod, which, as the mercury rises, presses against the inclined

plane, which causes the plate to move inwards and thereby diminish the air space of the pendulum.

3. A compensation spring stud for watches and other time-pieces, in which a balance and balance-spring are employed. Two or more compound arms in conjunction with two or more springs, to which the balance spring is attached, act in opposition to one another, and maintain the balance spring in one position, and at the same time strengthen or weaken the springs.

4. An improvement in the "two-pin lever escapement." This consists in "inserting a solid piece of ruby or other hard stone in the roller, and in placing the impulse notch in this ruby, and forming the lower part of the ruby so as to receive the fork of the lever."

5. A compensating pendulum consisting of three rods, the centre one being of less expansive metal than the other two; a tubular piece is made to slide on the centre rod; two spring levers are attached to the tubular piece, and weighted at their other ends by balls. The side rods are connected at the bottom with pieces attached to the spring levers, so that when the temperature rises the outside rods expand more than the centre one, and on a fall of temperature the contrary effect is produced.

6. A compensation collet to be attached to the balances of chronometers. The arms of the collet rest on the top of the balance which is slipped on to the same spindle. Near the fixed ends of the compensation pieces are two frames having valves placed within them; the valves in the first instance present their flat faces at right angles to the line of rotation or vibration of the spring collet; and in that position the pin of a small crank formed on the lower end of the separate spindles upon which they vibrate within the frames, takes into a slot in the free ends of the metal pieces. As the compensation pieces bend either outwardly or inwardly, the valves are turned round, and in either direction present less resisting surface to the air.

7. A compensation collet for timekeepers in which a balance spring is used. The free ends of the compensation pieces are attached by wires to a cross piece. Every increase of temperature causes them to bend in an outward direction, and thereby increases the leverage at which the spring acts upon the balance; while every decrease produces a contrary effect.

8. A method of compensating for variations in the density of the atmosphere by varying the sectional area of the pendulum. The barometric tube and float before mentioned are used. The pendulum bob has an opening in it, and the rise and fall of the float causes a door or valve to enlarge or diminish this opening.

[Printed, 1*s*. See Mechanics' Magazine, vol. 46, p. 435; and Patent Journal, vol. 2, p. 837.]

(To be Continued.)

METEOROLOGICAL OBSERVATIONS,

Taken at 9 A.M., NOVEMBER 1861.

Gray's Inn Road.

REMARKS.

The letters denoting the general state of the weather signify:—b, blue sky; c, clouds (detached); f, fog; h, hail; l, lightning; m, mist or haze; o, overcast; q, squally; r, rain; s, snow; t, thunder; rr, much rain; ff, dense fog.

On the 2nd a strong wind blew from NW all day; lowest barometer at 9 a.m.

The following observations relating to the severe gale of the 10th, may be of use.

	Bar.	Wind.	Force.	
9th at 8 a.m.	29·467	W	1	f
,, 3 p.m.	......	N	2	bc
,, 11½	29·638	NE	3	f
10th early, gale commenced at SE with rain				
,, 11 a.m.	29·193	SSW	10	qqrrtlh
,, 11½	29·183	SSW	7	mo
,, 1½ p.m.	29·191	SW	7	qo
,, 4	29·223	WSW	6	c
,, 7	29·342	WNW	9	qq
,, 11	29·440	WSW	6	b

It thus appears that the wind veered round the compass from W, to N, E, S, and to W. After this it veered to SW, S, SE, E, NE, N, and into W, by the 14th.

	Bar.	Wind.	Force.	
13th at 10 a.m.	29·72	E	3	rr
„ 3 p.m.	29·39	NE	5	rr
„ 12	29·01	NNW	8	rr
14th at 8 a.m.	29·32	WNW	6	bm

and a strong W wind for the rest of the day.

On the 21st there was also a moderate gale from SW, barometer at midnight 29·67, with rain.

The mean of the 9 a.m. barometer observations is 29·739. The lowest pressure was 29·01, at midnight of 13th, and the highest 30·61, at 10 a.m. 19th; which gave the large range of 1·6 inches.

The average temperature of November is 43° as determined by Greenwich data; during the last month the mean has been below this. The table shews 58° as the highest temperature, and 27° as the lowest, or a range of 29°.

Referring the 9 a.m. winds to the cardinal points, it appears the wind was N on 6 days; W, 15; S, 8; and E, one day.

Rain fell on 15 days, and the quantity was unusually large. Mr. G. J. Symons, the careful observer of Camden Town, measured the amount as 4·78 inches.

The weather of November has been very variable; the atmospheric pressure very unsettled; the temperature very changeable, through long ranges and very suddenly; wet and damp have been excessive; and several tempests of great severity have occurred. Storm warning signals have been frequently exhibited at the seaports. The following extract, from an official circular, having reference to such signals, is of interest.

"It should be remembered that only the greater and more *general* disturbances of the atmosphere can be made known by this method, not merely local or sudden changes which are not felt at a certain distance, and do not therefore affect other localities. Local changes may be indicated to observers at such places, by their own instruments,—by signs of the weather,—and by due consideration of the Weather Reports for a few previous days.

"Much inequality of electricity, atmospheric pressure (or *tension*), or temperature; great fall or rise of the barometer; sudden or rapid alternations; great falls of rain or snow, foretell more or less wind, with its usual accompaniments, either in some places only, or throughout an extensive area of hundreds, if not thousands, of miles. Some tracts, however, being unaffected.

"Speaking *generally*, there is far less occasion to give warning, of *southerly* gales, by signals, than of northerly; because those from the southward are preceded by notable signs of the atmosphere, such as a falling barometer, and a temperature higher than usual *at the season;* whereas, on the contrary, dangerous storms from a polar quarter (north-west to north-east) are sometimes sudden, and often are preceded by a *rising* barometer, which may mislead persons, especially if accompanied by a temporary lull of a day or two, with a fallacious appearance of fine weather. This fallacy is caused by one circuit, or cyclone, following and influencing a preceding similar though probably inferior movement.

"It should be kept in mind, that these signals are merely *cautionary*, to give notice of much atmospheric disturbance over some considerable part of the British Islands, without being in the least degree *compulsory*, or interfering with individual judgment on any occasion." R. S.

British Horological Institute.

NOTICE.

A Course of TEN LECTURES ON MECHANICS will be given Fortnightly at the British Horological Institute, during the months from November to March,—commencing on Tuesday, November 19th, 1861, by W. HISLOP, Esq., F.R.A.S., *Hon. Sec.* Chair to be taken at Half-past Eight precisely.

Division First.

Nov. 19 ... Lecture 1.—Introduction: Relation of the Science to Horology—Properties of Matter.

Dec. 3 ... „ 2.—Statics—Force—Equilibrium.

„ 17 ... „ 3.—Centre of Gravity

Division Second.

Dec. 31 ... Lecture 4.—Dynamics—Laws of Motion—Inertia.

1862.

Jan. 14 ... „ 5.—Second and Third Laws of Motion—Compound Motion—Reaction.

„ 28 ... „ 6.—Central Forces—Rotatory Motion.

Feb. 11 ... „ 7.—Gravitation and Laws of Falling Bodies.

„ 25 ... „ 8.—Gravitation (Second Lecture) Projectiles—The Pendulum—Effects of Gravitation on the Heavenly Bodies.

Division Third.

March 11 ... Lecture 9.—Mechanical Powers: Lever, Wheel and Axle.

„ 18 ... „ 10.—Pulley—Inclined Plane—Wedge—Screw.

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The Journal may also be had at the following Watch Tool Warehouses:—Delolme's, Rathbone-place; Ehnhues, 53, Frith-street, Soho-square; Grimshaw, 159, Goswell-street; E. Hunt, Ironmonger-street; Lowther, Red Lion-street; Muller, King-street, Soho; E. J. Thompson, 5 & 6, Percival-street; Williamson, Frederick-place; Greenhill, Sutton-street; Haswell, Spencer-street; C. B. Johnson, Market-place, Prescot, Lancashire; Lee, Wood-street, South; Fellows, Wellington-street; Margetts, "P.O." Goswell-street; and of all Booksellers in Town and Country.

THE BRITISH HOROLOGICAL INSTITUTE.

DISCUSSION ON THE BEST PRACTICAL MEANS OF IMPROVING THE CONDITION OF THE WATCH TRADE.

E. D. JOHNSON, Esq., V.P., in the Chair.

(*Continued from page* 56.)

Mr. JACKSON said, that having expressed a distinct difference of opinion from some gentlemen who had addressed them, he thought it might be appropriate to refer in a resumé of the observations made on the previous meeting, to the course the remarks had taken. Having done so, he continued the consideration of the question, by saying that the reputation in the world's market of the British manufacture was something worthy to be maintained. Making horizontal escapements with frictional defects was as beginning at the lowest step of the ladder. The English had not the tools and arrangements, nor the facilities for the proper division of labour as possessed by their foreign competitors to undertake such a contest. Mr. Bennett had expressed the proposition before them as one seeming to cut the matter short by jumping at a remedy. The discussion by general concurrence seemed to be confined to the production of a lower-priced watch for ordinary purposes, not embracing one where a price would be paid for high precision; and to the production of the former the opener directed his enquiries.

We have to consider his remedy of co-operation by a Joint-Stock Company with £1 shares. I must freely state that I think it would for a long time at least aggravate the disorder; and few of this generation would see the change he sanguinely looks to, should it ever come. I am not here to propose a remedy, not thinking it is to be found in any one particular state of things. The general co-operation of the members of this manufacture and a hearty desire for the advancement of its position would solve the difficulty; and that was the chief object in the foundation of this Institute. Already it had called attention to the important question of gauges, and it was hoped that before long the Museum Committee would be able to arrive at a standard of gauges.

Division of labour was a prime source of economy. The Swiss had carried out that system extensively without unhappy results. I am surprised that a plan for cheapening the lever escapement, while preserving its accuracy, has not been effected—I mean by the production of its various parts in rigid proportion; and easily accomplished now that escapement sectors will be obtainable, thanks to the Institute discussions and its Museum, so that any size of escapement might be obtainable, of accurate proportions and requiring only the pivoting, planting, and polishing, to complete it.

The remedy for the present state of things would not be found in mere discussion, but in a careful study of the best means of obtaining economy with accuracy. A discussion of this kind, though it may do nothing to promote invention—for that is an affair of the board, and of study—yet by disseminating existing knowledge, and by preventing useless experiments, may clear the way for the true remedy.

Mr. STORER.—We are arguing this question upon the assumption that the trade of watchmaking is on the decline in England. Mr. Ganney offers no proof of this. The simple reference to the large imports of foreign watches cannot be accepted as proof; indeed, the excess upon the last quarter, as stated by Mr. Ganney, can only be regarded as an evidence—in the present depressed state of commerce—of desperate trading.

Mr. Ganney has not thought it needful to prove his position. And there is no necessity to call upon him in particular to confirm a fact which others regard as true. Well then, admit that the watch trade is on the decline, that the watch makers bear a less proportion to the population than they did 20 years since. Some knowledge of the cause of this, if not suggestive of a remedy, may discover to us whether or no the case be remediable.

How long is it since England began to make such rapid strides in science? It is within the memory of men but past middle life. Regard the steam engine, that superior power designed to supersede manual labour. Can we trace the development of all the occupations consequent upon the invention of the locomotive! add to this, navigation by steam power, also, engines set up for local purposes, and we have a labour market of no ordinary capacity. Other scientific inventions, such as the electric telegraph and sewing machines, are continually opening new markets for labour. But how do these markets affect our trade? Turn for a moment to another thought. The time for taking apprentices by the dozen has passed; the system was a ruinous one, and failed to strengthen the trade—a feat it was never designed to accomplish. Some of the lads did not complete their term of apprenticeship; and many of those who did, being but half-taught, turned from their occupation in disgust, to fill a gap in one of the labour markets just alluded to.

We perceive then, gentlemen, that English watch-makers have been for a considerable period, surrounded by a mixed community following every conceivable avocation. Is it a matter of astonishment that the sons and apprentices of watchmakers should have been, and continue to be, drafted from amongst us, and thus, as a community, prevent our growth?

Such diversity of labour is not to be found in Switzerland, few if any temptations exist to decoy young men from the calling of their fathers; here Swiss energy is directed to watchmaking, as many members of this Institute have declared—watch

making is a family concern, and by it the people must sink or swim.

Then, there is a militating character in the genius of the English workman—a national idiosyncracy, inducing rather to the construction of steam hammers, than the ornamental trifles in which foreigners so excel.

Gentlemen, I have briefly drawn your attention to a very rational mode of accounting for the decline in our trade numerically speaking, if such decline has taken place. What is the remedy proposed? One in my opinion retrograde in character and mischievous in aspect.

Some years since, perhaps fifty, a repeating motion maker was to be found in London. Why was this department of the trade abandoned? I apprehend the reason to be this, the English being of an utilitarian spirit, preferred devoting their energies to the improvement of the watch as a time-keeper, rather than as a toy. The work was neglected, the foreigner studied it, and now produces a master-piece of mechanism.

From the time of Graham to about 20 years since, the horizontal escapement was essentially English—large, and beautifully handled. Place it by the side of the delicate Swiss escapement. The steam hammer and the sledge hammer contrasted, afford an analogy.

I have endeavoured to show that extreme delicacy of manipulation and minutiæ in detail are not exactly suitable to the genius of the English workman, and would from thence infer that the Swiss watch is not the thing for him to imitate; to do so would be with one exception a return to that which he has long since rejected, for that which he conceived to be better. The scheme is mischievous in aspect.

We have heard that privations are now endured by the English workman, and that the foreign workmen are suffering to an alarming extent. Gentlemen, the project is to make watches as the Swiss make them. This I cannot conceive will at all improve our legitimate position as watch makers; it will only be the training of workmen to a cruel competition with the inhabitants of a manufacturing district, who like the inhabitants of such districts generally seem subject to periodical returns of starvation.

I appreciate Mr. Ganney's motives, but do not consider the means he proposes equal to the end he designs. Indeed it appears to me as much a scheme of philanthropy as of trade improvement. Viewed in this light, it would be equally to the purpose to set up a competition against the Nottingham lace makers, or instruct our empty-handed artisans in the mysteries of ribbon weaving. I think the best and most effectual means to adopt would be to facilitate the power of production by the exactitude of system, we shall thus be enabled to manufacture as well as at present, cheaper, and retain also the wide world celebrity to which we have attained.

Gentlemen, commerce just now is not in a thriving condition. This is not only a great national evil, but also a primary social evil. Our immediate requirement is the advent of a genius who can remedy this; one able to clear the political atmosphere of the doubts, distrust, and horrors, which thicken it. Such a one would confer a blessing upon the world; and under the new aspect of affairs, the Clerkenwell watch makers would have but little time to anticipate the downfall of their trade. The idea is utopian. We must wait the tide of events, wait and hope; in the mean time slacken no efforts that may prove likely to promote our stability.

Mr. Mylne reminded the members that two years ago the council had agreed to recommend that a prize or gold medal should be given to any one for the best model of a going-barrel lever watch, and on reference to the reports of subsequent discussion meetings and correspondence in the Horological Journal, it was clearly proved by trials that such a description of watch had performed satisfactorily, and it was also shown by official returns that for many years past, there had been an increasing large demand for lower-priced watches, which in consequence of their not being made in England necessitated the large importation and sale of those of foreign production. The English manufacturers were therefore strongly urged to produce watches of the character approved by the Council, and thereby give continuous and abundant employment to every one engaged in the trade, without interfering with the manufacture and existing demand for first and second class fusee watches. A decided preference is given for English lever watches in this and all foreign countries; in these watches this country stands pre-eminent, and from past experience will long continue to do so. The proposition therefore to re-introduce the horizontal escapement will find few supporters in this Institute. What is wanted are good sound watches of the size, form, and external appearance suitable for the prevailing taste and fashion, and at such reduced prices that will place them within the reach of those who now purchase the better class of foreign watches, and who will buy nothing else but a flat watch at a moderate price; and the present high state of perfection to which the lever escapement has been brought in its various forms and prices especially adapts it not only for first-class watches but also for every other class of manufacture. The course proposed by the Council was in his opinion a prudent one, as doubtless prizes would follow for improved escapements and all other portions of the watch.

The Council have evinced the importance they attach to a standard gauge of measurement as of primary value in an improved system of manufacturing; in the meantime we may proceed with making all the improvements so urgently required.

Mr. Guillaume then said: The question is one in which it is most difficult to interfere, because a trade, like a constitution, grows—it is not made. It has to be fostered; but it takes a long time to see the results and reap the benefits; so that, in whatever you propose, you must expect to disappoint and displease the many. Your measures, if wise and prudent, will be thought quite inadequate to meet the wants of the times; for although Mr. Ganney very properly disclaims any attempt at relieving the present depression, and has altered the heading of his paper, still we cannot divest the question altogether of its actuality; especially the outsiders will not. Among the causes of the

gradual drifting away of the trade, some are permanent and some temporary. The temporary causes are mainly beyond our reach, being found in the agitated state of the world, and affecting our brethren and competitors in Switzerland even more than ourselves. Among the means of permanently improving our manufacture, we must distinguish between the measures which would have to be adopted by all concerned, or, at least, by the generality, in order to be of any use, and those which any individual or company may carry out for themselves; else we may lose the whole of the charter by impracticably aiming at the whole, when we might have obtained a part.

One point which will have to be agreed upon by nearly all before we derive from it all the benefits it can bring, is a more perfect system of measurement. This is strongly felt, if we judge from all that has been said; but it strikes me that suggestions on this head would more properly be addressed to the committee appointed for its special consideration, or else we shall be doing the work twice over. It suffices in this discussion to enumerate this point as a necessity upon which we all agree, and then to wait for the report of the committee. As to the adoption of any particular movement, of a calliper, of such or such an escapement, some of the suggestions contained in the paper seem very practical; but be sure that no decision of an Institute—no, nor any act of parliament—would ever induce people to abandon suddenly their faith in the lever or in the fusee. Any change would be of slow growth. The new watch will have to show its face in the world, and to be tried, and to win confidence, before you can sell it. But let any one produce the watch, a sound timekeeper, of simple construction—and be sure that, should it even be rather dearer than common Swiss watches, it will be bought in preference to them, not only in this country but in America and the colonies. We need not ostracise our good old friend, the lever—it will yet do great service—but that must not prevent you trying your skill at horizontal wheels and cylinders. The Swiss have not rejected any escapement, although they might as well have left the lever alone.

I will say more; do not attempt to imitate Swiss watches; imitation seldom succeeds; and you cannot easily copy their light decorations, for each nation has its peculiar gifts; and you may be sure that you could never attain to the cheapness of Swiss work—not that the Swiss live upon nothing; but the nature of their country is such that all the watch-makers are in the same districts; consequently everything is arranged for the greatest devolpment of this particular branch of industry; and, moreover, they have in their neighbourhood whole districts inhabited by poor uncultivated French peasants, who do most of the cheap parts of the watch. They make scape wheels, cylinders, &c., at a price upon which the Swiss would starve; and we hear in Switzerland, when trade is slack, the same complaints against these people that we hear in Clerkenwell against the importers of Swiss goods. Besides this cause of cheapness, it is true that they have also, as has been ably said, a very efficient division of labour and proper tools; but that division of labour is not carried to the extent some suppose. You have shops in this country where the work is subdivided as much as the Swiss can do it; but some of the principal branches of the trade are distributed differently, and with evident advantage. For instance, you let the finisher complete the movement, and put the watch together after it is gilt; but as you do not let him have the case, you have to examine the watch and do many things to it after it is gilt which ought to have been done in the grey. The Swiss have the watch pivoted and planted—as they call running the wheels—by one or two hands; after which it is handed to the "repasser," who examines, gets the watch sprung and gilt, and puts it together ready in the case. There is an evident advantage in that method.

I am told there are strong reasons for having watches finished without the case, and examined afterwards; but can this be a normal state of things? Would it exist if all classes of the trade were brought together more than they hitherto have for good, so as to act beneficially on one another? There is also less factory work in Switzerland than we are given to understand; movements are perhaps the only part made in factories, of which there are two or three only in the country; the rest of the movements for the best watches being made in shops. If a large shop is called a factory, then we may add that jewel-holes are the produce of factory work, but there, I believe, it ends; for the escapement maker, the finisher, the examiner, take the work to their own houses. Women are employed with advantage in springing and in polishing. They have not, however, had a material influence in cheapening labour, but many an unprotected female has thus been saved much misery till the time she could exchange that occupation for that of ministering to the daily wants of a partner.

Much has been said, also, about the system of education, and the facts adduced are true; but, alas! have you ever found a system, either good or bad, which produced all the evil or all the good that was expected from it? While I was listening to the eloquent description of the state of education in my country, I felt somewhat like that good French bourgeois gentilhomme, Mons. Jourdain, when he learnt for the first time that he had spoken in prose all his life: I marvelled. We have good schools, but there are in all countries people whom you can never educate. Besides, instruction tells more upon the manufacture when found in the manufacturers than when forced upon the workman. My friends will understand that I am not disparaging instruction, but only preventing misconception as to its direct effect. One thing, which goes further, is the training spoken of, which makes every citizen feel that he is something in the community, and which develops his faculties. My conclusion is, that in time you may certainly give an impulse to the watch trade by adopting a simplified movement, but of a true English character; and also by greatly modifying your process of manufacture in the direction hinted at by several speakers, and helping as much as you can the committee in their endeavours to realize a standard gauge.

The CHAIRMAN (Mr. Johnson) said: As one of the Vice-Presidents of the Institute, he ought not to remain silent. They had heard the proposition of

Mr. Ganney and Mr. Bennet ably answered. Mr. Ganney's system of co-operation was what was formerly known as Fourierism or socialism. There was no doubt that their attention should be largely called to improvement in the process of manufacture. The want of English watch makers was the cultivation of the genius of machinery. They had a beggarly lot of tools, trusting more to finger and thumb than to them. They were subjected to the derangement of their nerves, so much so that they were sometimes obliged to give up the execution of a particular piece of work for the day. Machinery was not liable to such derangement. The most elaborate was only improved tools. They were much indebted to the lever, but it was not capable of doing everything from its very large power of expanding its vibration, which rendered it unsuitable to the going-barrel. The lever had been a failure when applied to Swiss watches, a fact which Mr. Guillaume would corroborate; but not so with the fusee, which Mr. Tilling had pointed out the desirability of maintaining in connection with the lever escapement, because at one end of a watch or another there must be an adjustment for isochronism.

Mr. Watson was surprised that the going-barrel as a remedy should have been brought forward again, because its merits had been discussed in that room nearly eighteen months back. The first point to be settled was a standard of measurement. The Exhibition would bring together a great number of workmen from all parts of the world, and advantage should be taken of that circumstance to hold a conference with them upon the subject. The question of whether it should be a going-barrel or a going-fusee was nothing; five per cent would cover the difference between the two. They might as well talk about going back to the verge watch as to the horizontal escapement as the best timekeeper. It rested entirely with the balance spring, and not the main spring. The markets were so glutted with the worst description of foreign watches, that it was more injurious to their own more respectable manufacturers than it was to us.

After a few observations from Mr. Tilling and the Chairman, the discussion was adjourned until the following Wednesday.

(To be Continued.)

LECTURES ON MECHANICS,

In course of delivery, at the British Horological Institute.

By W. Hislop, Esq., F.R.A.S., Hon. Sec.

(*Continued from page* 58.)

Air can be rarefied so far that the contents of a cubic foot shall not weigh the tenth path of a grain. If a quantity that would fill a space of 100th part of an inch in diameter be separated from the rest the air can still be found there, and we may reasonably conceive that there are several particles present, though the weight is less than the 1,700,000,000th of a grain. But further than this, we have many remarkable instances of the divisibility of matter proved from the wear arising from friction. In some of the continental churches the marble pavements before the statues of saints have, in process of time, been worn away by the knees of the worshippers, while the feet of the images themselves have become perfectly smoothed and in some well-attested cases absolutely destroyed by the kisses bestowed upon them. Now each pair of lips must have carried away a portion of the statue, infinitely small indeed, but sufficient, when often repeated, to produce very visible results. In machinery also, and especially small machinery, very remarkable illustrations of this property may be found. In a watch, for instance, there are several wheels and pinions constantly in action, and as constantly wearing, and yet 50 years is a very ordinary age for a watch, while many may be found in an efficient state after 80 or 100 years. Take an instance, that of a horizontal watch, which has a hardened steel cylinder, on the axis of which the balance is placed, and into which (half of it being cut away) a wheel with 15 small wedge-like teeth acts. In process of time this steel cylinder becomes worn by the edge and point of the tooth, and a shallow cut is thus made round it. This, however, may not take place for 15 or 20 years. Now, the weight of the whole of this cylinder is about two grains, and the part acted upon certainly is considerably less than one-tenth of a grain; when this is cut half through the cylinder is useless, so that 1-20th of a grain has been removed. Now the balance makes about 14,000 vibrations in an hour, and at each of these vibrations the tooth passes over the cylinder and contributes to its wear. 14,000 vibrations in an hour is equal to 336,000 in 24 hours, which multiplied by 5475, the number of days in 15 years, gives us as the number of vibrations in that time 1,839,600,000. If now we distribute 1-20th of a grain, the amount of wear in 15 years, over this number of vibrations, we shall find that the utterly incomprehensible quantity of one 37,000,000,000th of a grain has been removed at each vibration! I have not made the most of this as a case; smaller watches have cylinders not 1-10th of the weight of the one instanced, and their wear is much less in proportion, while there are many parts of a watch still more minute.

Indestructibility.—Matter is absolutely indestructible; however it may be treated, and in

whatever manner its particles may be rendered invisible to the sight, still it exists, and must continue to exist in some form or other. Sublimation and distillation are instances of this fact, and we ourselves are composed of particles of matter as old as the creation. The ancients were accustomed to burn the bodies of their honourable men, in order that they might not be degraded by being turned to base uses; but although they saw the bodies no longer, they did not therefore cease to exist, but their various particles merely entered into new combinations. In fact, the means adopted were the most effectual that could be desired to compass the opposite of their intentions, for by burning they disseminated the particles of the bodies through the air, causing them to be inhaled by the basest and most worthless of the surrounding concourse.

Porosity.—Matter being formed of particles in a greater or less degree of closeness to each other, there are a number of interstitial spaces which are either empty or filled with some substance, the particles of which are smaller than those of the body in question. These interstitial spaces are called pores; the greater the density of a body the less the porosity, and *vice versa;* thus, if the pores of a body exposed to the air be greater than the atoms of the air, those atoms will pervade these pores. Thus water contains air; this can also be shown in the cases of many kinds of chalk and wood, by placing them in a glass vessel of water beneath the receiver of an air pump and then exhausting the air, when all which exists in the pores of the body will escape in streams of bubbles.

Compressibility.—Matter is compressible, that is, it may be reduced in volume without lessening the number of particles or its weight. This is effected by bringing the particles closer together, and thus diminishing its porosity and increasing its density. All known bodies may be compressed, and this is another proof of porosity, for the space by which the volume is reduced must before have consisted of pores. Metals are hammered and rolled in order to harden them by thus bringing their particles together, and wood may be compressed till nearly as heavy and hard as metal. Liquids are but little compressible and yield but slightly to very intense pressure. Two huudred years ago the philosophers of an academy at Florence made experiments to ascertain this fact. They filled a hollow ball of gold with liquid and firmly closed up the aperture Now it is an axiom in mathematics that if the figure of the globe be changed, its volume or contents must necessarily be diminished; hence it was inferred that if the figure of the globe could be changed by intense pressure without bursting it, the compressibility of the liquid would be established. The shape was altered, but the liquid was found to escape through the pores of the gold, and was thrown on the surface in the form of dew, proving, not the incompressibility of the liquid, but the porosity of the gold and comparative smallness of the particles of water. Canton, in 1761, settled this point by subjecting a liquid contained in a tube to intense pressure, when the surface of the liquid was found to fall and rise as the pressure was applied or withdrawn. This fact may be also proved, so far as aeriforms are concerned, by a glass vessel inverted in water. If the surface of the water within it be watched it will be found to rise a very little in the inner vessel as it is pressed down. The air gun depends for its action on this property of compressibility; the air being mechanically compressed into the reservoir, and being allowed to escape suddenly, by its expansion drives the bullet through the barrel.

Dilatability.—Is the opposite of compressibility, allowing for an increase of volume without an increase of mass. It may be effected by the removal of a pressure already existing upon a certain body. Thus, in this collapsed bladder is confined a small quantity of air; now, if this is placed beneath the receiver of an air-pump, and the pressure of the air removed from within that receiver, we shall find that the air within the bladder will expand, and the expansion is evinced by the swelling of the bladder. As soon as the air is re-admitted, and the pressure thereby again exerted, the bladder again collapses to its original dimensions. Another agent in the dilatation of bodies is heat. An increase of heat increases while an accession of cold decreases the volume of a body. Thus, if heat be applied to a tube containing a liquid, the latter will be found to rise in the tube, and the amount of its rise will be in direct proportion to the degree of heat employed. This is the principle of the thermometer. The change of dimension of solids by heat is much less than that of liquids or aeriform liquids, and therefore not so easily observable. The pyrometer is an instrument in which the expansion of a bar is multiplied by means of levers, which also move an index which points out the amount of expansion in a plainly visible form. Cast iron is found to expand 11-10,000ths of its length in a variation of temperature equal to that between the freezing and boiling points, and brass about 18-10,000ths under the same circumstances. From these data we find that cast iron, when exposed to the air in this country and taking the lowest degree of cold in winter to be equal to zero, or 32 degrees below the freezing-point, and the highest degree of heat when exposed to the sun to be equal to 120 degrees—under these circumstances cast iron will expand 8-10,000ths of its length. If then it be a bar or beam 84 feet long, the elongation will amount to rather more than 8-10ths of an inch. This expansive property is taken advantage of in making the wheels of carriages. The rim of iron on the exterior, called a "tire," is made smaller than the wooden portion; it is then heated, and thus expanded, and while in this state is forced over the wheel, and being suddenly cooled, it contracts its dimensions, and binds the wheel together with an enormous force. Steam boilers are made of sheets of iron riveted with hot rivets, which, contracting in cooling, bind the plates together so that the vessel is air-tight. A familiar instance of expansion is furnished in the process of extracting fixed glass stoppers from bottles by means of external heat expanding the neck of the bottle and releasing the stopper. When walls are found to bulge they are frequently restored to perpendicularity by means of iron rods placed through them, which, being heated, plates are screwed on their ends against the wall, and then they are

allowed to cool, thus drawing the wall into an upright position. Plumbers, in laying down lead or zinc upon roofs, are constrained to allow for expansion by arranging the metal with folds, for if this were not done disruption would speedily ensue. In fact, every object round us is continually altering its dimensions through the agency of heat. The stability of Bow church was endangered some years since from this fact. Some portion of the edifice was sustained by iron pillars; these expanded in summer and raised the stonework, so that a crevice was occasioned, into which dust insinuated itself. When winter came, the pillars contracted, but the masonry did not sink to its former level in consequence of the insinuated dust and dirt. A crevice was therefore now left between the top of the pillar and the stone above; this in its turn became filled up, and when the pillar again expanded, it lifted the superincumbent mass higher than before, till at last these repeated lifts completely disintegrated the masonry, and rendered extensive repairs necessary. Even brickwork expands and contracts. Messrs. Cubitt have found that the chimney of their factory expands 5-8ths of an inch in 90 feet by the heat of their furnaces. In the construction of all kinds of buildings, then, this property must be carefully taken into account, especially when various materials are used. As a familiar instance of unequal expansion, I may refer to a glass tumbler; if it be placed on a hot surface it will crack, and the same thing occurs if heated liquid be poured into it. This arises from the surface first heated expanding more rapidly than the more remote portions, and therefore rupturing them. Spirits, again, measure five per cent. more in summer than in winter, so that the best policy is to buy spirits in winter and sell them in summer.

Cohesion. — Another property of bodies is cohesion. This is not strictly a universal property, inasmuch as it exists in its greatest extent in solid bodies, is exceedingly modified in liquids, and altogether wanting in aeriform fluids. Now, if the particles of matter were endued with no property in relation to each other, the universe would be like a mass of sand without gravity; atoms would neither cohere as in solid bodies, nor repel each other as in aeriform fluids. Thus the atoms of bodies are not merely placed together, but a force exists between them, and this force is called cohesion. Take a piece of iron and attempt to separate its parts, and the effort will be strongly resisted, and it will be much easier to remove the whole mass. This force of cohesion varies according to the nature of the body; thus putty has but little cohesion amongst its parts, while steel or iron has a large amount. The cohesion of particles in juxtaposition is of the same class as the approach of particles placed at a distance from each other. The same influence which caused the bodies A and B to approach will, when they unite, oppose a resistance to their separation; therefore this force is called the attraction of cohesion, while that force which draws bodies to the earth is called the attraction of gravitation, and that exercised by the magnet is called magnetic attraction. There is another kind of attraction called capillary attraction, which is the force resulting from the affinity which the particles of liquids have for solids, Adhesion is the term used for cohesion when liquids are concerned, and also when bodies stick together when their surfaces come into contact. Thus, when this plate of glass is laid upon another and pressed into close contact and then raised, it will lift the undermost plate with it. If the plates are not very flat, and consequently touch each other in many points, this effect will not take place, the amount of cohesion being exceedingly small for each particle. The actual force of adhesion may be measured by suspending one plate to the arm of a balance, and having first accurately poised it, placing the plates in contact, and then adding weights till the plates are separated. Writing with chalk, charcoal, plumbago, and the like, may be adduced as familiar instances of the adhesion of solids. Now, if these plates be moistened with water they will adhere still more strongly, and if the plate be allowed to touch the surface of the water in a suitable vessel, and then be lifted up, the water will follow it till its gravity overcomes the force of adhesion. A large portion of these effects may be owing to the pressure exerted by the atmosphere, but the same results are found in a limited degree in an exhausted receiver. If a solid can be wetted by a liquid they have mutual adhesion or affinity. A drop of water placed upon the table loses its globular form and spreads upon the surface, while a globule of mercury will not do so. When the liquid becomes solid, adhesion gives place to cohesion, as in the case of gum, glue, paste, and the like.

All bodies have a certain amount of gravity, that is, they have weight, and tend to the grand centre of gravitation, which is the earth, with a greater or less degree of force. They have also inertia, which is that property which resists the impartation of motion, and when imparted resists its abstraction; in the latter case it is frequently called momentum. Of the properties of gravity and inertia I shall have to speak more at length, as many phenomena are caused by them, and various laws of their action will have to be considered.

In my next lecture I shall commence that division of mechanics known as Statics.

(*To be Continued.*)

ON THE PENDULUM.

Second Lecture.

Delivered by E. D. JOHNSON, ESQ., F.R.A.S., *for the* HOROLOGICAL INSTITUTE, *at* SPA-FIELDS LECTURE HALL, *October* 16*th*, 1861.

MR. KLAFTENBERGER, V.P., IN THE CHAIR.

(*Continued from page* 60.)

The next principle to whose application to the pendulum, I propose to advert is the Equality; that is to say, the equal time of the long and short vibrations. You will remember, that I pointed out the following law of bodies:—that in proportion to the directness of the fall would be the distance the body would fall through in a given time and the velocity with which it would move. The first proposition is a consequence of the second. Here again you see that if I move this pendulum a given distance on one side there is a certain amount of elevation for a large amount of longitudinal deflection. [Referring to a simple pendulum]. Now this continually increases with each subsequent deflection, there being a closer and closer approximation to a direct fall until it becomes an absolutely straight and direct fall. Starting from that point it passes through all the intermediate spaces, and finally arrives at the central position at the same time as it would have occupied had it been started from any intermediate point. The indirectness of the manner in which the gravity acts gets greater and greater as the body has to start from a less and less elevation, and consequently takes all the time to cover the short space as it did to cover the long one, because it has no time to acquire velocity. On the contrary, starting from the highest position, whence the fall is direct, the body gets rapidly into motion, and with that acquired rapidity enters into every subsequent division of the space, as all falling bodies do, acquiring yet increased velocity in every particular division, until it reaches its maximum at the point where the pendulum would stand if at a state of rest; and it is this acquired velocity or momentum which carries the pendulum up an equal height or nearly so, on to the other side, which is its maximum point. Strictly speaking, as I mentioned last Wednesday night, it has been demonstrated that only one curve or arc is what we call properly isochronal; that is, absolutely equal in time. That one curve is the cycloid. I have here traced a cycloidal curve which is generated by marking a point on any circle rolling along a straight line, in order that you might see the difference in amount between a small portion of that one and a circle taken at the lowest point of each, by which you will observe that that difference is wonderfully small. It is also a property of this cycloid that it generates its like kind in any flexible ordinary form of pendulum, bent upon its surface, supposing it to project, the cycloid would then be traced by the molecule or bob of the pendulum. Here is another which is one-half the cycloid I have described by those means. I must mention, in passing, that this was originally designed by Huygens at a time when pendulums were made to swing in enormously wide arcs, the mechanical application being in the form of a pair of cycloidal cheeks, with the intention of making a portion of the line forming that pendulum take that form by bending against them as it swung; in those days it being usual to employ those larger arcs of vibration in connection with the crown-wheel escapement, which gave freedom for such an extensive swing. No good ever came of such a contrivance in the old, and it was totally inapplicable in modern horological machinery, in consequence of the very reasonable amount of vibration employed or permitted by a superior escapement, such as that of Graham. I want to call your attention to a fact in connection with this point. Here I have drawn a portion of a cycloid, and immediately below it I have drawn from the centre, with the rod of the pendulum, part of a circle. Is it possible to conceive anything nearer to a coincidence, than these two parts or lines represent, if only a short arc be taken? The wondrously small difference between these arcs with regard to isochronism, or departure from the same, is still of some importance to give attention to, because insignificant as it apparently is, those minute portions are continually stored by the pendulum, and in time their accumulation becomes something more than visible.

There have been three very capital attempts made to isochronize pendulums by other means. We suspend, for example, a pendulum by a spring. There are still, I believe, such phenomena as persons who believe that no other purpose could be subserved by that spring except as a mere means of hanging a pendulum flexibly, or of supplying an axis of motion without friction. But it can be made to serve another and more important function still, namely, to help us to an approximation to an absolutely isochronous pendulum. The form here employed is a flat spring. This is necessary to prevent a pendulum intended to vibrate in a plane from degenerating into a circular or elliptical path, and so becoming a pendulum of another kind entirely. But independent of that, the spring can be made to serve every purpose by applying a little more rigidity to the long vibration than to the short one.

The elder Mr. Frodsham was one of the earliest experimenters in this department of horological science, and his experiments were performed in this wise. Let that (referring to a sketch), represent the flat piece of spring to which the pendulum is suspended. On the top of the pendulum Mr. Frodsham slipped tightly a piece of tube, which may be represented here, (referring to the diagram), the top of it formed a pair of

jaws which embraced the spring tightly. You see that this contrivance effectually lengthened or shortened the pendulum spring, by pinching it at a point according to where the tube was slipped up the rod and was fixed by its binding screw. But if this spring was originally graduated, with regard to thickness, by shortening or lengthening that portion of the spring left capable of bending, it had the effect of supplying exactly that quantity or rigidity in the spring that the particular pendulum demanded, as ascertained by the result of experiments.

Dr. Lardner suggested, but with a very different intent from those that went before him, to try a pendulum spring that should be isochronous. There were also a variety of mechanical means devised for making pendulums vibrate in cycloidal arcs; but these were all abandoned. Prominent among these, and one that will give you a good idea of the character of all, you will readily understand as I draw on this black board. Supposing a rod of iron mounted on brackets, projecting a short distance from the wall, lying perfectly horizontal; then imagine the upper part of the pendulum rod split in two, and passing up on either side of the rod to the axis of a grooved wheel rolling on the bar. You will now see, that if that bar or rod is carried slightly upwards on either hand it would compel the bob of the pendulum to travel in a path equivalent to that amount of bend which might be averaged to represent a cycloid or any curve desired. But it is evident that there must be an enormous amount of friction and a very great quantity of power required to keep a pendulum so suspended in motion. I have seen one most carefully suspended by a very skilful workman in this way, but it never did any good. It was suggested that the pendulum spring should be made conical and tapering downwards; so that yielding in proportion to its flexibility, increasing of course in the same ratio, it became positively a curve; on being bent the same thing must occur on the other side. This upper end, if rigidly fixed, is supposed not to move at all. This was designed to keep the motion of the mass of the pendulum in a cycloidal path, which naturally must fail because of the enormous amount of force necessary to bend any considerable part of such a spring.

(To be Continued.)

BERTHOUD'S DESCRIPTION OF HIS MARINE TIME-KEEPER, No. 8.

TRANSLATED FROM HIS "TRAITE DES HOROLOGES MARINES."

Paris, 1773. *Chap.* x. *page* 271.

(*Continued from page* 50.)

The spiral of the Chronometer No. 8, marked No. 19, at 5 degrees of the balance makes equilibrium with 12½ grains.

At 10 „ 25 grains.
20 „ 50½
120 „ 309

If the progression be constant, the last term ought to be 300 grains; difference on excess, 9 grains; and this excess causes a deviation of 1″ 35‴ per hour, in the rate of the chronometer when the large arcs are of 250 degrees with a motive force of 5 lb. 14½ oz., or that the arcs make 220 degrees with a force of 4 lbs.

The same spiral No. 19 of the chronometer No. 8 being fixed upon the balance at the same point where the curb pins act when the chronometer is regulated, that is to say at the same point where they were during the sea trials,

At 5 deg. the spring was poised by 3½ grains
10 „ „ 27½
20 „ „ 54¾
120 „ „ 332

The same spiral rendered shorter:
At 5 deg. made equilibrium 14½ grains.
10 „ „ 29
120 „ „ 352

ought to be 348, difference 4 grains in excess.

The spiral No. 19, which was to the chronometer No. 8 during the sea trial, not being so perfect as I desired, I tried one marked No. 15, which had been tried formerly. This spring is made in tempering the strongest at the centre; it is 12½ inches in length, weight 41 grains, its breath $1\frac{7}{12}$ lines; makes 8 turns, and has 8 lines in diameter.

This spring put on the balance:
At 30 deg. draws 55 grains.
120 329

and to be 330, difference 1 grain less; this spiral spring will be most certainly fit for isochronism.

Before applying the spiral spring No. 15 to the chronometer No. 8, I dismounted it from under its collet in order to warm it and fix its form.

The spiral spring being fixed on its collet, I adapted it to the chronometer to find the requisite length for isochronism; and I am assured by accurate experiment, that this spiral must be perfectly isochronous. To this end having rendered it longer, the large arcs of vibration were slower than the small arcs; and on the contrary, having rendered it shorter, the large arcs of vibration were quicker than the short arcs; it is certain therefore that there is between these two limits a point in which the compensation should be exact. But we must observe, that to be able to lengthen or shorten the spiral by small quantities, it is necessary to dispose the stud in a suitable manner; so that pinning in the spiral it does not strain it out of its natural form. To that end, the pressure ought to be made by a screw or a kind of vice, like that in my first marine chronometer. I executed in consequence the stud* in the manner of those represented, Plate XX. *fig.* 5.

Remarks.

To estimate exactly the quantity to lengthen or shorten the spiral, it must be measured by the number of degrees run over by the balance. Thus, the banking pin being constantly at zero when the balance is at rest, by loosening the screw of the stud you will then have an opportunity to put the balance backwards and forwards, in order that the banking pin passes over 3, 4, 5, 10 degrees &c.; this done, tighten the screw of the stud again, and note in the journal how many degrees you have lengthened or shortened the spiral; then bring back the collet of the spiral so that the banking pin of the balance be at O. You must then set the chronometer going, proving it by different weights; and if, for example, it gains in the long arcs, whilst before it gained in the short arcs, and that the length of the spiral has been for this effect augmented by 10 degrees of the balance, we loosen the screw of the stud, and turn the balance to shorten the spiral about half the number of degrees that we had made it run over formerly, that is to say, 5 degrees; and so on by little and little until we arrive with certainty at the most perfect isochronism that can be obtained. This done, you ought not to touch the spiral again, but regulate the chronometer by augmenting or diminishing the mass of the balance, which you will do by the addition of the three masses disposed in the manner which we will explain further on.

* This pin is of tempered steel, 9½ lines long; size, 6 lines; thickness of the foot, 1 and 1-12th line; of the vice, 3 lines 1-6th.

Second Remark.

We have seen by our experiments, that the thickening of the oils* in the escapement has caused a losing in the chronometer No. 8 of 2½″ in 24 hours, and this effect has taken place when the arcs of vibration have been diminished by 30 degrees. But, if we so dispose the spiral that the arcs of 210 degrees be more prompt than those of 240 degrees by 2¾″ in 24 hours, this will produce a compensation which will be in the ratio of the resistance to the oil of the escapement, so that the oil shall not be able to affect the justness of the marine chronometer, for in the same measure as the oil thickens, and consequently that the oil of the escapement tends to make the chronometer lose, the arcs of vibration will become at the same time smaller; and the oscillations, through small arcs, becoming in proportion quicker, there will result a perfect compensation. You must therefore so regulate the isochronism of the spiral before adding the small masses to the balance to regulate the watch.

Of the Masses to be put to the Balance, as well to give the balance the weight proper for the Spiral, as to poise it by their means.

In order that the masses which we add to the balance, may serve at the same time to regulate the chronometer and to poise the balance, without being obliged to give or take away any portion of the weight; they must

* I had thought that to give to this machine all the perfection possible, one could do this by disposing a stop piece holding a reservoir of oil to renew now and then the oil of the escapement; by this means, the arc of vibration would constantly preserve the same length, or nearly approaching thereto, without having recourse to the proposed compensation in this remark; but, although this idea of the reservoir be very seductive, I avow that the application is not easy, as well to make the reservoir preserve a mass of fresh oil, as to communicate it to the wheel of the escapement, without risking anything; I therefore renounced for the present this project. These are the means which I proposed to make trial of the reservoir disposed very simply; it is formed by two sorts of cups opposed to each other at the summit, having between them on one side a notch, into which the oil ought to meet, to communicate to the wheel once a month. I make this detent act in a manner to complete surely the desired effects, it must be that each time you wind up the chronometer the weights on arriving at the top shall advance a tooth of a star-wheel of 30 teeth. At the third tooth, that is to say, at the end of 30 days, at the moment when the star-wheel changes, the spring (santoir) which serves at the same time as a detent to the reservoir, will start forward, and for an instant impinge on the escapement wheel, and one or two of its teeth will receive a small drop of oil; a tooth of the star-wheel slightly larger than the others would produce a similar effect in its passage over the spring (santoir).

be so disposed that they can approach or recede from the centre of the balance. For this effect, you must fix on the flat rim of the balance, and at equal distances from the centre, three pieces of metal of the same weight, and poise them with the balance; these ought to be put on with screws, and graduated to estimate exactly the quantity, when they retire from or approach to the centre of the balance, whether it be to poise the balance or to regulate the chronometer, and without touching the spiral, which we suppose to be at the requisite point for isochronism.

In the first place, the masses must be placed in the middle of the rim of the balance, in order that all being of the same weight, the balance be in poise; and it is necessary moreover to give to these three masses the proper weight, to be added to the balance, in order that the chronometer may be regulated to the actual force of the spiral spring. The masses then being of the required weight, or approaching thereto, you must perfectly poise the balance, by approaching the one and retiring the other of these masses, in order not to disturb the rate of the chronometer.

We must recollect that it is absolutely necessary that the screws of these masses have no play in the holes of the taps, and for that purpose you must split the holes of the screws, in order that they make a spring, and press the screw of the masses pretty strongly, so that they cannot turn but by a firm and gentle pressure. These masses ought to be pierced the length of their screws, and turned on a smooth arbor, in order to be able to diminish them at pleasure. In order to turn these masses, you are to avail yourself of a sort of turnscrew, in which a point enters into a hole of the centre, and the other in an eccentric hole. I executed, in consequence, these masses with much care, and I regulated as near as possible the chronometer before taking it to pieces to clean it, and to add to it the detent or stop of which we shall speak presently, serving for the transport of the machine.

Of the Detent employed to the Chronometer No. 8, *to stop the Balance during the voyage by land.*

In order to send the marine chronometer No. 8, in a manner to avoid making the voyage to Brest myself, I packed up this machine with sundry precautions, by means of which I was able to assure myself that a person with infinitely less intelligence than M. le Chevalier de Borda, would be able to transport my marine chronometer, set it going &c., without fear of accident. I applied myself particularly to protect the balance, and to so hold it, that the pivots of the friction wheels should not be in action, and that the suspension spring of the balance be equally guaranteed from all danger; the detents of which I am about to speak will accomplish this double office.

The mechanism of this detent is formed by a cross of three branches, which is placed under the little plate of the friction wheels underneath the balance; this cross carries fixed therein three pins or little pillars, placed at equal distances; these pillars, which cross the plate of the friction wheels, go under the balance; this cross can either ascend or descend; when it is ascended, the three pillars which it carries act in the middle of the rim of the balance, and serve to lift it equally by its circumference, in such a manner as not to damage the pivots of the rollers; and the balance being then sustained its spring of suspension ceases to support it; and this spring is thus protected, as well as the balance and rollers, from all accident.

To raise or depress this cross, I employed a detent, the arbor of which is put in a frame, between the dial-plate and the lower plate of the regulator. The axis of this detent carries a strong arm, of which the end terminates in a fork, and passes beneath the centre of the cross; the end of this fork (between the prongs of which passes the axis of the balance) is formed on an inclined plane; this inclined plane, sliding underneath the cross, raises and stops the balance at the same time; and this effect is exercised in a manner that each pillar of the cross equally sustains the balance, without supporting its axis on one side more than on another. When we would set the chronometer going, you must remove the arm of the fork of the detent, so that the cross ceases to raise the balance, and removing itself therefrom falls by its own weight; but to render this effect still more sure, this cross is obliged to re-descend by the pressure of a strong spring, made like a fork, that passes in a groove formed through the plate of the cross piece.

The upper end of the axle of the detent carries an arm which passes level with the under side of the dial plate: on this arm is fixed a pin which passes across an aperture made in the plate; this aperture regulates the course of the detent, whether to stop or to set the balance in motion, this arm of the detent causes a friction against the plate; but to insure the effect of this detent more certainly than by friction, and to render the chronometer less liable to derangement by being carried, I have put a screw which firmly fixes the detent in two points, viz

that by which the balance is stopped and that by which the detent ceasing to rise the balance becomes free.

The detent for stopping the balance being finished, I cleaned and re-mounted the movement with much care, and finished the regulation of the spiral, so that the long arcs should be slower than the short ones, and fixed it at such a point that when the balance described 240 degrees the chronometer lost 4″ in 24 hours more than when these arcs made 205 degrees. By these means, the compensation which we have proposed is somewhat strained, but, for want of time I fixed the spiral at this point, which nearly approached the requisite position. This isochronism of the vibrations of the regulator having been fixed in a manner in which I have just said, I occupied myself with the compensation, and I tried the chronometer subseqently in different temperatures, of which the following Table is the result.

*Equations for the effect of the Temperature.**

The Thermometer of Reaumeur being

3 degrees	= 38½ Fahr.	.....0 correction.		
10 ,,	54½	,,	fast 1½″	in 24 hours.
13 ,,	64¼	,,	,, 2″	,,
15 ,,	65¼	,,	,, 2½″	,,
17 ,,	70¼	,,	,, 1¼″	,,
20 ,,	77	,,	,, 0½″	,,
25 ,,	87½	,,	,, 0″	,,

In a word, to achieve that which concerns the corrections done to this chronometer No. 8, when I was occupied in rectifying the movement of this machine, I had the suspension re-worked as well to render it more simple, and more solid, as to give more range to its vibrations; and I do not doubt but that it will now realise all the conditions that are required.

(*To be Continued.*)

* It is this table of the temperature that I remitted to M. Le Chevalier de Borda at the same time as the chronometer. (See Appendix No. 11.)

NOTICE TO CHRONOMETER MAKERS.

The Annual Competitive Trials of Chronometers at the Royal Observatory, Greenwich.

It is the intention of the Lords Commissioners of the Admiralty at the conclusion of each of the annual competitive trials of Chronometers at the Royal Observatory, in future, to offer honorary prices for the two chronometers which may stand first in the order of merit, provided that their performance during the trial be not below the standard of merit established in former years. But as that standard of merit may not always be attained by chronometers on trial, their lordships in such cases reserve to themselves the power of withholding the honorary prices for that trial; and in other cases of repeated excellence of the chronometers on trial they may extend those prices to the three best. The prices offered on all occasions will be determined by the absolute merits of the chronometers.

2. Chronometers intended for the annual competitive trial, which is always to commence in January and to terminate about the following August of each year, will be received at the Royal Observatory on the first Monday of the year, or on any day of the preceding week, by the usual mode of letter from the hydrographer, between the hours of 9 A.M. and 2 P.M. But no chronometers will be received for the competitive trial later than that day on any account whatever.

3. Chronometers makers are at liberty to annex a price to their chronometers when placing them on the competitive trial.

British Horological Institute.

NOTICE.

A Course of TEN LECTURES ON MECHANICS will be given Fortnightly at the British Horological Institute, during the months from November to March,—commencing on Tuesday, November 19th, 1861, by W. HISLOP, Esq., F.R.A.S., *Hon. Sec.* Chair to be taken at Half-past Eight precisely.

Division First.

Nov. 19 ... Lecture 1.—Introduction: Relation of the Science to Horology—Properties of Matter.

Dec. 3 ... ,, 2.—Statics—Force—Equilibrium.

,, 17 ... ,, 3.—Centre of Gravity

Division Second.

Dec. 31 ... Lecture 4.—Dynamics—Laws of Motion—Inertia.

1862.

Jan. 14 ... ,, 5.—Second and Third Laws of Motion—Compound Motion—Reaction.

,, 28 ... ,, 6.—Central Forces — Rotatory Motion.

Feb. 11 ... ,, 7.—Gravitation and Laws of Falling Bodies.

,, 25 ... ,, 8.—Gravitation (Second Lecture) Projectiles—The Pendulum—Effects of Gravitation on the Heavenly Bodies.

Division Third.

March 11 ... Lecture 9.—Mechanical Powers: Lever, Wheel and Axle.

,, 18 ... ,, 10.—Pulley — Inclined Plane—Wedge—Screw.

METEOROLOGICAL OBSERVATIONS,

Taken at 9 A.M., December 1861.

Gray's Inn Road.

Remarks.

The general state of the weather is recorded by letters, signifying:—b, blue sky; c, clouds (detached); f, fog; m, mist or haze; o, overcast; q, squally; r, rain; rr, much rain.

The wind veered round from W to N, E, S, and to W, between the 30th November and 5th December.

On the 8th, before daylight, a very violent WSW wind blew for some hours.

The whole of the 13th was very stormy; wind from S, SW, and W.

The mean of the 9 a.m. barometer observations is 30·15. The highest pressure observed was 30·62, on 27th at 11 a.m.; the lowest 29·24, on 7th at 8.m. The range, therefore, was at least 1·38 inches.

The mean temperature of December, according to Greenwich data, is 39°. During the past month the average is higher.

Referring the wind observations to the cardinal points, we find it blew from N, on 9 days; E, 10; S, 6; and W, 6.

Rain fell on 11 days. There has not been any snow. A prevalence of fog and haze has characterized the weather. Northerly and easterly winds have been constant for the last 17 days, accompanied with a high barometer, and dry though hazy weather; nevertheless the cold has not been so severe as might have been expected for so long a continuance of polar winds. R. S.

EQUATION OF TIME TABLE

For February, 1862.

Day of the Week.	Day of Month	At Apparent Noon. — Equation of Time to be *added* to Apparent Time.	Difference for One Hour.	At Mean Noon. — Equation of Time to be *subtracted* from Mean Time
		m. s.	s.	m. s.
Sat...	1	13 53·37	0·313	13 53·29
Sun...	2	14 0·89	0·279	14 0·83
Mon..	3	14 7·57	0·244	14 7·51
Tues..	4	14 13·42	0·209	14 13·37
Wed..	5	14 18·42	0·174	14 18·38
Thurs.	6	14 22·60	0·140	14 22·57
Frid..	7	14 25·95	0·105	14 25·93
Sat...	8	14 28·48	0·072	14 28·46
Sun...	9	14 30·21	0·039	14 30·20
Mon..	10	14 31·14	0·005	14 31·14
Tues..	11	14 31·27	0·028	14 31·28
Wed..	12	14 30·61	0·059	14 30·62
Thurs.	13	14 29·20	0·090	14 27·22
Fri...	14	14 27·03	0·121	14 27·06
Sat...	15	14 24·12	0·151	14 24·16
Sun...	16	14 20·50	0·181	14 20·54
Mon..	17	14 16·17	0·210	14 16·22
Tues..	18	14 11·14	0·238	14 11·20
Wed..	19	14 5·44	0·265	14 5·51
Thurs.	20	13 59·09	0·292	13 59·16
Frid..	21	13 52·10	0·318	13 52·17
Sat...	22	13 44·48	0·343	13 44·56
Sun...	23	13 36·25	0·368	13 36·33
Mon..	24	13 27·43	0·392	13 27·52
Tues..	25	13 18·02	0·416	13 18·12
Wed..	26	13 8·04	0·439	13 8·14
Thurs.	27	12 57·51	0·461	12 57·61
Fri...	28	12 46·45	0·483	12 46·56

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TIME SIGNALS AT THE INSTITUTE.

THE Council has great pleasure in announcing to the Members, that, mainly through the exertions of one of their Vice-Presidents, Mr. E. D. JOHNSON, they have at last succeeded in obtaining Time Signals direct from Greenwich Observatory in the office of the Institute. All who are acquainted with the subject will acknowledge how great a boon this must be to those engaged in the manufacture of timekeepers, and in all the delicate operations which form the practical portion of the science of timing it will ere long be still more highly valued.

In order to understand the nature of this acquisition it is necessary here to state that the Astronomer Royal has especially set apart two hours in the day for the use of the Institute. The mechanism of the Motor Clock at the Royal Observatory, is so arranged as to give hourly signals. Some of these hour signals were already especially appropriated, and of those which remained the hours of 2 and 3 P.M. are reserved for the use of the Institute. The signals are conveyed by a special wire along the South Eastern Railway, and through the communications of the British and Irish Magnetic Telegraph Company, and District Telegraph Company, to the Instrument in the Council Room of the Institute. The instrument is simply an upright Galvanometer shewing an index in front (see engraving), which, when the current passes is instantaneously deflected. It has been proposed to associate with the time signals a first-rate Regulator Clock, to be purchased by subscription, the time rate of which can then be periodically ascertained and posted in the office. Through the generosity of Mr. E. J. THOMPSON, a subscription is rendered unnecessary as he has presented them with a Clock by REID & AULD, which is in itself for its principle of construction, as well as beauty of workmanship, an object well worthy a place in the Museum, in addition to serving as a Standard Timekeeper for the Members.

The Council deem it due to Sir CHARLES BRIGHT, C. WHITEHOUSE, Esq., and G. V. WALKER, Esq,. also to acknowledge its obligations to those gentlemen for the exertions they have successfully made to overcome the difficulties which presented themselves in the course of the undertaking.

THE BRITISH HOROLOGICAL INSTITUTE.

THE ANNUAL DINNER.

The FOURTH ANNUAL FESTIVAL was held on the 25th ult., at *The Freemason's Tavern.* About one hundred members and friends of the Institute sat down to dinner, presided over by the Right Hon. the LORD MAYOR.

Amongst the gentlemen present were—Mr. Sheriff Cockerell, Mr. Valentine Knight, President, Mr. Cole, Mr. Klaftenberger, and Mr. E. D. Johnson, F.R.A.S., Vice-Presidents, Mr Hislop, F.R.A.S., Honorary Secretary, Mr. C. V. Walker, Electrician to the South-Eastern Railway Company, Professor Tennant of King's College, J. Jones, Esq., Mr. J. C Webb, Treasurer, Mr E. J. Thompson, Trustee, Mr. Gordon, Editor of the Journal, Common Councilmen Bennett, F.R.A.S. and Connell, Mr. Charles Frodsham and Captain Frodsham, Mr. J. Passmore Edwards, Editor

of the Mechanic's Magazine, Mr. Wilson, Barrister-at-law, Mr. G. F. Mylne, Mr. Mc Donnell, Representative of Clerkenwell at the Metropolitan Board, Mr. A. Wright, Senior Churchwarden, Mr. Vestryman Foster, Messrs. Trewinnard, Blackie, Walsh, Marriott, Crisp, Watson, Brooks, Guillaume, Smith, Wm. Lewis, Solicitor, Mardens, Britain, Eve, Causeway, Farmer, and De Pecca.

The Musical Arrangements were under the direction of Mr. A. J. Cooper, assisted by Mrs. Cooper, Miss E. Howard, and Mr. C. Selwyn, who during the evening sung several glees and solos in a very beautiful manner. Grace having been said,—

The Lord Mayor rose and said,—Gentlemen, I cannot propose to you the health of the Queen in the cheerful manner in which I might once have submitted to you the health of that illustrious lady, because unhappily she is in a state of mental suffering which must necessarily continue for a long period of time. Her exalted position, the most extraordinary in the world, only renders her suffering the more severe, because she has lost not only her husband, but her partner in her cares of office and in all her labours, and one to whom, according to her own account, she was so much indebted in every respect. She never can move with the happy and joyous elasticity with which she heretofore went about. I am sorry to have to speak in this melancholy strain; but you would not be satisfied with your Chairman, if on such an occasion as this, in proposing the health of such an illustrious person, whose name is so great throughout the world, I was to do so in a cheerful manner. I give you, The Health of the Queen.

The toast was drank in respectful silence.

The vocalists sang the glee, "God save the Queen."

The Lord Mayor,—His Royal Highness the Prince of Wales, has undergone a transition lately, and has entered upon a new position in life. He is no longer a minor, but having arrived at maturity is thrown upon his own resources. Usually, young men, under such circumstances think that their own resources are quite sufficient to guide them; we have, however, reason to hope, judging from the antecedents of his Royal Highness, and from the manner in which he has hitherto acquitted himself, that his good sense will be sufficient to keep him in the path of prudence, to carry him safely through the ordeal he is about to undergo, and to preserve him in every trial and temptation to which persons in such an exalted sphere and at such a time of life are necessarily exposed. He has now gone abroad to gain a knowledge of the world, so desirable for every one to possess, and so highly necessary especially for persons in the elevated position which he occupies. We have great reason in every way to rejoice in such a royal family as we have in this country, which is a pattern and example to the whole world. Think of the education they have received, and the admirable manner in which their illustrious parents have brought them up. The country is deeply indebted to Her Majesty, and to her late Prince Consort for the care they have bestowed on the education of their children.

The toast was drank with applause.

The Lord Mayor,—Gentlemen, the next toast I have to propose to you is "The Army, Navy, and Volunteers." At the present time the country is enjoying a happy state of security; if, however, it had not been for the army and navy I can hardly tell you in what a condition it would have been. Certainly under Providence Great Britain owes its tranquility and happiness to the efficiency of its army and navy. I dare say there are no old soldiers here, but there may be persons who may recollect, as I do, the time when the fate of the country appeared to depend upon the issue of a naval action which it was known was about to come off. Just imagine what would have happened to us if we had lost the Battle of Trafalgar. It was our navy which won that engagement for us, and saved the country. After that, matters became easier. The navy having completed its work the army came into action. How well it performed its duty let the Peninsular bear witness. It was then a question whether the whole continent of Europe was to be overrun by a great conqueror, or whether the independence of the nations was to be maintained. That independence was established mainly through the bravery of British troops. Well, we went on for forty years without war; but within this last few years we have been plunged into it again. There sprung up an apprehension of foreign invasion. That feeling took such a deep root in the minds of the people that it was evident that some movement must issue from it, and the result was the starting forth, as though by magic, of the Volunteer Corps all over the kingdom. But for them, our government would not have felt the perfect confidence they had in taking the steps they adopted recently in reference to the affair of the Trent. But for them, the country would not have felt quite so easy under the insult it had received; but we were enabled to dispatch to Canada ships of war and regiments of the line, because we knew that we could leave the country with safety in the hands of those who had stepped forward for its protection. The demand upon the American government was made, and reparation was obtained. We owe that result partly to our volunteers. What a glorious thing it is to know that we shall not want our army and our volunteers, simply because of the demonstration they have made to the world. I believe we have no old sailor here, or any officer of the line, but we have present several gentlemen connected with the rifle movement, and amongst others the son of a gentleman near me, Captain Mills Frodsham, with whose name I will couple the toast.

The toast was drank with applause.

Captain Frodsham in returning thanks, said,—My Lord Mayor and Gentlemen. After the speech which has been delivered by our able and gracious chairman, I have very few words to say in behalf of the volunteer movement. I am glad to say that the riflemen have not been called out, and I believe there is very little chance of their being so; but if they should be, I am confident that they would show themselves equal to any emergency which might arise. The volunteers are, and always have been, proud of their corps since the Lord Mayor of the City of London set the example of coupling their names with those older institutions of the country, the Army and the Navy. On behalf of the Volunteers I beg respectfully to thank you for the toast you have just drank.

[A verbatim report of the remainder of the proceedings will appear in our next number.]

List of Donations to the British Horological Institute, *at the Annual Dinner, February 25th*, 1862.

	£.	s.	d.		£.	s.	d.		£.	s.	d.
The Right Hon. the Lord Mayor	10	10	0	W. Connell, Esq.	5	5	0	J. F. Cole, Esq.	2	2	[illegible]
Valentine Knight, Esq.	10	10	0	Professor Tennant	5	0	0	C. Mill Frodsham, Esq.	1	1	[illegible]
Sheriff Cockerell	5	5	0	John Jones, Esq.	5	0	0	Geo. Blackie, Esq.	1	1	[illegible]
Sheriff Twentyman	5	5	0	Samuel Jackson, Esq.	3	3	0	J. C. Webb, Esq.	1	1	[illegible]
Chas. Frodsham, Esq.	5	5	0	John Bennet, Esq.	2	2	0	Thomas Leonard, Esq.	1	1	[illegible]
E. D. Johnson, Esq.	5	5	0	C. J. Klaftenberger, Esq.	2	2	0	J. W. Knight, Esq.	1	1	[illegible]

	£.	s.	d.		£.	s.	d.		£.	s.	d.
B. Marriott, Esq.	1	1	0	A. P. Walsh, Esq.	1	0	0	— Sitch, Esq.	0	10	0
S. A. Brooks, Esq.	1	1	0	David Glasgow, Esq.	1	0	0	E. Brown, Esq.	0	10	0
E. Storer, Esq.	1	1	0	J. Austen, Esq.	1	0	0	C. Reineker, Esq.	0	10	0
C. Guillaume, Esq.	1	1	0	Benj. Foster, Esq.	1	0	0	J. D. Lutiger, Esq.	0	10	0
W. S. Wilson, Esq.	1	1	0	J. F. Watson, Esq.	0	10	6	J Lecluse, Esq.	0	10	0
An Honorary Member	1	1	0	J. B. Delletrez, Esq.	0	10	6	G. Schoof, Esq.	0	10	0
Thomas Earnshaw, Esq.	1	1	0	William Thoms, Esq.	0	10	6	A. Staam, Esq.	0	10	0
J. R. Warman, Esq.	1	1	0	Robt. Paget, Esq.	0	10	6	J. Mechin, Esq.	0	5	0
Luke Hansard, Esq.	1	1	0	Alex. Wright, Esq.	0	10	6	C. Valogne, Esq.	0	5	0
Thos. Ransom Sacks, Esq.	1	1	0	William Lewis, Esq.	0	10	6	Appraised value of Clock presented by E. J. Thompson, Esq.	19	0	0
Thos. Benfield, Esq.	1	1	0	— Wright, Esq.	0	10	6		£118	17	6
P. Macdonald, Esq.	1	1	0	A Visitor	0	10	6				
J. Whischer, Esq.	1	1	0	A Visitor	0	10	6				
Alfred Greenwood, Esq.	1	1	0	Thos. Mercer, Esq.	0	10	0				

DISCUSSION ON THE BEST PRACTICAL MEANS OF IMPROVING THE CONDITION OF THE WATCH TRADE.

E. D. Johnson, Esq., V.P., in the Chair.

(*Concluded from page* 66.)

Mr. Jones, of the Strand, re-opened the discussion. He who could give a practical answer to the question, "How shall we remedy the present unnatural depression of the watch trade by a successful competition with Switzerland?" might make his fortune directly. He agreed with Mr. Guillaume that they must not attempt mere cheapness as a means of effecting that object. The English workmen had many more occupations to fly to than had the Swiss peasantry. He (Mr. J.) did not deny that price was an element in competition. The British watch maker had materials at his disposal with which to make a much better fight than he did make. In Lancashire there were men engaged in the trade, many of them trained to very considerable lightness of hand, and who with a little additional practice would be capable of undertaking far more of the details of finishing than belonged merely to the movement. They were earning but 16*s*. or 18*s*. a week, although their workmanship was unsurpassed in the world. A much larger proportion of the business might be done by them than they now performed, if they introduced a system of measurement, and such improvements as the three-pointed tool which the Chairman had introduced to the meeting that night. By those means a very considerable reduction might be made in the price of the watch. It was not absolutely necessary that the English should be as cheap as the Swiss watch. If they could reduce the price 25 per cent. the competition with the Swiss would thereby be very much abated. During the discussion a great majority of the speakers were in favour of the lever escapement in preference to the horizontal movement. The difference of cost, especially with improved tools, need not be very material. He was surprised to find a return to the horizontal movement advocated. It was said that the going-barrel was quite sufficient for ordinary watches. He had made a dozen of them, and found that the average difference of the whole during twelve hours was only a quarter of a minute, and any particular one did not vary from it. That was an immaterial quantity of time for the ordinary business of life. Then, again, the English manufacturers were not half so bustling as were the Swiss. Workmen had a right to claim of the manufacturers an equivalent amount of energy in pushing their trade to that which manufacturers required of the workmen in furnishing the article at an economical price In the shop windows in Paris there were more watches to be seen than in those of the makers in London. In that of Mons. l'épine he saw five hundred. Throughout the Palais Royal and the principal streets of Paris he saw but two English watches exhibited for sale; the one of which was an English lever, the name of the maker of which he forgot, a gold-plate hunting lever watch, the price of which was twenty guineas. It had upon it the distinctive mark "*Anglais*," implying an admitted excellence of quality on the part of the English maker. The sale of watches of that kind at those high prices was a temptation to the London manufacturers to go over there and dispose of their good quality of work, which he believed would sell there, because he found that the small watches were not pushed forward as a prominent feature, but those of the size twelve and heights, 0, would come quite within the dimensions of the English three-quarter plate movement; if that was the case in France, it would be much more so in Holland, where larger silver watches were worn, such as were in use in English country towns. With regard to subdivision of labour, he thought that there was an evil in so much of it as was suggested. The operatives did not see the connection between their work and the final result. Good work was not capable of being produced without the workman had a final purpose in his mind, and knew that he should take care not to damage other branches of the trade. All should co-operate to that good result at last in the pocket of the wearer. Co-operation should be kept in the view of the workmen; the vigilance of the master should be combined with the excellence of the workmen to produce the good result. The intelligence of the Lancashire workman was superior to that of the Swiss peasant, notwithstanding all that they had heard about the prevalence of education in their mountains. He believed that the colli ion of mind with mind amongst men in large towns gave an amount of activity to their intelligence which was not found amongst workmen

elsewhere. If, then, they could find new markets for the sale of their watches, reduce the price of the middle-class work, by employing Lancashire men who are already trained to hand, but who were going from the watch to the cotton and other businesses, and who were said to be almost in a state of starvation, much good might be done without displacing the London work.

A long conversation ensued upon the influence of machinery and improved tools in bettering the condition of the trade.

Mr. GANNEY then replied as follows:—

Mr. Chairman and Gentlemen,—We may congratulate the Institution and the trade in general on the very fair and impartial manner in which this question was discussed on the evening it was opened; and it is much to be regretted that a full and complete report of that meeting was not inserted in the *Clerkenwell News;* for it certainly appears to me that the remedy proposed by me for improving the condition of the trade has been, if not entirely neglected, certainly very little discussed. The remedy I proposed was simply the co-operation of those most interested in extending the trade and reputation of English watch work. In the paper I read I endeavoured to show the anomalous position of the watch trade; and that, whilst depression and distress has existed in connection with the watch manufacture, a very large and increasing retail trade has been done in this country. It does not require statistics to convince us of this; the greater portion of watches exhibited in our retailer's windows being foreign, and our own appearing, "like angel's visits, few and far between." Within the last eight years the introduction of foreign watches has increased from 40,000 to 200,000 per annum. The Board of Trade returns show an increase of 60 per cent during the present year. I then mentioned that numbers of these watches were sold as the production of English workmen. Since then I have been pleased to observe that the words "English finished," &c. have been removed from the tickets on these watches by some of the worst offenders in this respect. I attributed this increase to the greater suitability of foreign watches, by reason of their beauty, and the low price they are supplied at. This they accomplished, I believe, by the adoption of a simple form of movement and escapement—*viz.* the going-barrel movement and the horizontal escapement,—and urged a strict investigation into the merits of the horizontal escapement, though I did not intend to exclude the lever. I then endeavoured to show that foreign workmen are as well paid as our own, and that what we lacked was not the means but the practical application of them to improve and extend our manufacture. The co-operation of all who took an interest in the success of our manufactures appears to be the best means of attaining that object; and we know that great success has invariably attended manufacturing co-operation. We may reasonably expect a trial of it in connection with horology Mr. Bennett, in commenting on the remarks contained in the paper, acknowledged the superiority of the horizontal escapement for general purposes, urged the adoption of the Swiss movement, and gave us, as the result of his personal experience, a very interesting account of the educational advantages enjoyed by foreign horologists. He expressed his concurrence with all that had been advanced in the paper read, with the exception of that which related to the selling of foreign watches as English, and did not consider that retailers had found it necessary to deceive their customers to increase their trade. I do not think such a course necessary, though the higher prices obtained for English watches has made such a course to some of our retailers very profitable. Mr. Cole gave us a very lucid explanation of the merits of the horizontal escapement; and though he had devoted much time to study and perfecting our knowledge of the lever escapement, yet, by reason of the intricacy and multiplicity of parts in the lever escapement, he did not think it so well adapted as the horizontal for a popular watch, and concluded by expressing his approval of the proposition advanced. Mr. Hislop bore testimony to the superiority of the horizontal escapement for general use, by reason of its great simplicity, but did not approve of the Swiss movement, and the unsound manner in which the going barrel is secured to the frame; and did not consider co-operation advisabie for manufacturing purposes. Mr. Tilling objected strongly to the going-barrel movement and horizontal escapement and considered the lever could be made cheaper, though it would not keep time with the going-barrel. The latter statement he afterwards retracted, he not having had experience in the timing of watches. He strongly urged the necessity of the watch movements being made under the direction of the manufacturer, and considered that a simple movement made in large quantities could be produced at a low sum. Mr. Styles urged the adoption of gauges to facilitate production, and pointed out the great amount of labour wasted in the finishing of the movement, owing to the want of a system of proper proportions in the making of the movement. Mr. Storer bore testimony to the durability of the horizontal escapement, as exemplified by a watch in his possession, having gone some years with very great accuracy. At the resumption of the discussion, Mr. Jackson urged the necessity of maintaining the English reputation, and did not approve of the horizontal escapement, it being a frictional one, and not generally understood in this country; and thought the general co-operation of the trade and a hearty desire to improve the condition, would solve the difficulty. Mr. Storer considered the great increase of the foreign watch trade in this country due to desperate trading, and showed that many of our younger workmen became disgusted with the trade, and only those who could get nothing better to do continued at it. He considered the remedy proposed as mischievous and retrograde in character. Mr. Mylne considered that English watches ought to be supplied at 4*l.* for silver and 10*l.* for gold. We now come to the best speech of the evening. Mr. Guillaume gave us a disinterested and full analysis of the whole question, and plainly pointed out the advantages to be derived by making a simpler watch. I will not attempt to criticise his statement, every sentence being pregnant with useful information. I have endeavoured to give you a disinterested, and, as far as possible, impartial view of the question; and I may remark that the practice of praising our own productions, and disparaging those of

others, is an error likely to produce much trial and misery. It is not wise to under-rate the strength and abilities of our competitors. It has been shown that the simpler escapement is better adapted than any other for ordinary purposes. Though preferring the lever escapement to the horizontal, I cannot be blind to the fact that the great increase in the watch trade has been owing to the adoption of it by the Swiss. On the principle that there is "nothing like leather," I have great preference for the lever, and certainly should not recommend its disuse, though I think a large trade might be done by making simpler watches with the horizontal escapement. What is wanted is the association of practical men for the carrying out any plan that might be shown to be advantageous; and co-operation is the thing that is wanted. It has proved a great success wherever the plan has been adopted, giving to all interested an amount of self-respect and energy that no other means are calculated to effect. The co-operative plan is not a mere enthusiast's vision, but a noble fact, of which every Englishman should be proud. More than a million of money is at the present time invested in it by the working classes Good results have already attended the introduction of co-operation into the trade; the Coventry Watch Tool Society, on the co-operative plan, having supplied many of its members with superior tools, who otherwise would have been unable to obtain them. The speaker concluded by reading the following report of some remarks of Lord Brougham on co-operation:—

"In his Inaugural Address at the recent Congress of the Social Science Association, held in Dublin, Lord Brougham thus favourably expressed his views on the Co-operative movement:—In the great department of Social Economy, much attention was at the last congress given to the important introduction into the manufacturing districts of the co-operative system—the establishment of unions by the working classes, for the purpose of sharing in the profits on the goods consumed or used by them, as well as preventing adulteration of those goods, and for the purpose of carrying on both branches of manufacture; in both these kinds of union the progress has been very great since last year; and in the latter those doubts which seemed to exist of the scheme's practicability have been almost altogether removed. Above 50 companies for manufacture have been established since last congress besides many of mere stores. In these last a capital of 500,000 is invested; but in the former the manufacturing concerns, represent, a capital of £2,000,000, exclusive of the Manchester Cotton Company (limited), whose capital is £1,000,000. The returns of Mr. Tidd Pratt show the creation of above 250 co-operative societies within the last twelve months, all enrolled under the Friendly Society Act. It is not wonderful that the members of such unions should be of an educated class; but that they should often exercise themselves in literary labours is remarkable. Besides entering into competition for the prizes offered by the *Dial* Newspaper, and by Mr. John Cassell, whose volume containing above 20 working men's essays, I have just received, the working men of Manchester carry on a monthly journal of co-operative progress "*The Co-operator*", without the help or interference of any other class. A number of this work now lies before me, from which it appears that in the second year of its existence the sale has reached 12,000; it is well conducted, and a hope is expressed of improveing it when what they term "the detestable duty on paper" is given up. As might be supposed, the savings and the profits of these good men are in part applied to public purposes and charity. Thus at Rochdale, they have given to the town a drinking fountain, and contributed £50 to the Indian Relief Fund, besides smaller yearly sums to the dispensary and the deaf and dumb institution. The effect of co-operation in preventing those strikes so pernicious to the working classes and so dangerous to the peace of the community, has been everywhere felt. The late strikes at Colne may be ascribed to the want of co-operative unions in that district; but the mischiefs occasioned, and which left their deep traces behind, opened the people's eyes to their error, and the consequence has been the establishment in that district within the last three weeks of a shed with 700 looms, upon the co-operative plan. It is important to observe that, with another subject anxiously dwelt upon as well as strikes, at all our former meetings, the great cause of temperance has been intimately and most naturally connected. Not only are such of the contributors as had before been subjected to intemperance weaned from their habits, but it is mainly to temperate habits that the formation of these unions may be traced. Exceptions there may no doubt be, but as a rule co-operative societies are composed of sober and industrious men. Another subject referred to by Lord Brougham on the same occasion, is of the highest social importance, and its discussion was never more seasonable that at the present moment—that of co-operative firms or companies amongst the working classes. Nothing is likely to have a more salutary influence on these classes, than the spread of this system It would enlighten them in the most direct and practical manner, on the very subjects about which they continually fall into the most serious and fatal mistakes. Wherever a co-operative firm is established, the partners learn by experience the value of capital and the true relation of capital to labour; and this is the very knowledge which would most powerfully help to prevent the recurrence of the greatest evils that afflict industry in this country—strikes and the undue influence of trade unions. If the association can multiply those practical schools of social economy, it would do an enormous service to the industrious classes of the country. And from the president's encouraging report, it appears already to have effected something in this direction."

The CHAIRMAN proposed a vote of thanks to Mr. Ganney, which was passed and replied to. A similar compliment was paid to the Chairman.

Mr. TILLING wished to correct an error which Mr. Ganney had fallen into. That gentleman stated that he had altered his views respecting the going-barrel watch; he had not done anything of the kind.

Mr. JACKSON thought that Mr. Ganney was under a mistake, also, in representing Mr. Cole as favourable to the adoption of the going-barrel movement.

Mr. FARMER, although not a member of the Institute, requested permission to reply to an observation of Mr. Ganney's, spoken at him (Mr. F). and implying a censure. The reason that he had not published the opening speech of Mr. Ganney was the he (Mr. F.) had a defect in his constitution, which probably Mr. G. did not possess—that of not being gifted with ubiquity. Being compelled to be elsewhere on the night in question he was through the unfortunate defect referred to, unable to be at the Institute. Mr. Jackson had, however, given on the following night what was admitted to be a fair *résume* of the previous debate, which was inserted verbatim in the CLERKENWELL NEWS.

Mr. GANNEY repudiated any intention of imputing blame to Mr. Farmer in the matter.

MECHANICS,

Second Lecture delivered to the BRITISH HOROLOGICAL INSTITUTE.

BY W. HISLOP, ESQ., F.R.A.S., HON. SEC.

December 3d, 1861.

In entering upon the more immediate consideration of the science of Mechanics, I propose to divide the subject into three distinct sections.

The first, upon which I enter this evening, is that division known as Statics, from the Greek word Στατοσ, in which bodies are considered as under the influence of forces which fail to produce motion and therefore produce equilibrium.

The second division will be Dynamics, from the Greek word Δυναμισ, and relates to bodies acted upon by forces which do not equilibrate, but from which motion results.

The third and last division involves the consideration of the Simple Mechanical Powers.

In presenting this branch of Mechanics before you, I have found considerable difficulty in arranging the results of research in a sufficiently attractive form for a lecture and in accompanying it with experiments calculated at once to demonstrate propositions and interest the mind. I hope therefore that if my lectures should not prove satisfactory, so far as interest is considered, you will be able to give me credit for endeavouring to make them complete.

The term "force" (or power) is used to denote any cause or agency which has a tendency to put, or which actually puts, a body at rest into motion, or which has a tendency to destroy, or which actually destroys, the motion which a body may already possess. Thus, if a body which is at rest be submitted to the action of two or more forces, such as two weights, one of two effects must ensue —either the body will continue in its state of rest, or it will begin to move in some determinate direction, and with some determinate force. If, as in the case before us, the body continues at rest, it necessarily follows that the forces which act upon it are so related as to their direction and intensities, that they neutralize each other, or mutually destroy each other's effects; under these circumstances the body is said to be in a state of equilibrium, the forces in fact balancing each other.

We also apply the term "equilibrium" to the forces which act upon the body; thus we say that these forces are in equilibrium.

But if the forces which act upon the body be not so related as to neutralize each other's effects motion must ensue, and the body will be urged by some determinate force in some determinate direction. Thus, if the proportions of these weights in the foregoing experiment are altered, motion results. The first of these cases, with the laws which govern the equilibrium of forces, is included under the division Statics, and involves a class of problems relating to the intensities and directions of the forces which keep any body in equilibrium. By understanding these laws we are enabled to solve these problems, and thus are able to predict, on the one hand, whether a body urged by given forces shall receive any motion or not, and, on the other hand, when motion or rest obtains, to discover the forces occasioning either.

We will first define the various kinds of forces. Forces may be divided into three classes—Impulsive, Uniform, and Variable.

Impulsive forces are those which act but for an instant, after which they cease to act. Take as an instance any sudden blow, as that of a hammer or cricket bat; also the cases of arrows shot from a bow, balls projected from guns, and the like. The balance also of the superior description of watches are put in motion by a sudden impulse, and the more momentary this is, the less effect will be produced on the accuracy of the instrument by irregularities which may happen in the wheel work.

Uniform forces are those which act constantly or incessantly with the same degree of energy. Gravity is an uniform force; if the body be kept at the same distance from the centre of the earth, pressure will be uniform, and perhaps this is the only strictly uniform force which is known to exist.

Variable forces are those which act incessantly, but every instant with different degrees of energy. The wind, for instance, is constantly varying in its force; the tides, likewise, and streams of rivers vary in their strength in proportion to the time of year and the nature of the season, and gravity itself varies in its intensity of force if the body be made to vary its distance from the centre of the earth.

These forces may be either accelerating or retarding, according as they are employed in the production or destruction of motion. An accelerating force is one which continues to act upon a body notwithstanding it may be in motion. Hence its velocity becomes accelerated. The descent of bodies down inclined planes, or their fall from a height, are of this character, their weight, and consequently the force of gravitation which causes them to fall, not being diminished by the act of falling.

A retarding force is one which tends to destroy any motion. Friction is a retarding force, and the atmosphere also offers a resistance to the passage of any body which soon destroys its motion. A falling body will at last attain a rate of uniform motion, from the fact that at a high velocity the air offers a resistance which is equal to its weight or to the force of gravitation.

A force may either draw towards it or push from it; in the former case it is called an attractive force, as in the case of gravitation, and also in the force exhibited by the magnet; in the latter case it is called a repulsive force, of which gunpowder, with its effects, may be taken as an illustration.

The effect of a force depends: 1st, upon its intensity; 2nd, upon its points of application; 3d, upon its direction. The intensity of a force is its greater or less facility of producing or destroying motion, and may be also denominated its magnitude. This is usually measured by similar effects produced by some other force taken as a standard. The standard which naturally suggests itself to the mind is weight. The weights of different masses, that is to say, their tendencies to the earth, are different, and require different forces to counteract them. An ounce weight, for instance, must be opposed by an equal force before it will be maintained in equilibrium; thus, assuming any weight as an unit—say one pound—any other weight or force which produces the same statical effects is equal to one pound. It is upon this principle that all balances, scales, and instruments for measuring forces are constructed.

If a material point be urged by any one force, it ought necessarily to move in a straight line, for no reason can be assigned for its deviation either to the one side or the other; thus if a ball be let fall it proceeds in a straight line towards the earth, there being but one force in operation. If, however, the ball be thrown from the hand in a horizontal direction two forces affect it; one constant, drawing it downwards, the other impulsive, throwing it forwards; as it loses the momentum caused by the latter force it gradually approaches the earth, tracing in its course a portion of the curve known as the parabola. This may very plainly be seen when a stone is thrown at any object. It must rise considerably above that object during a part of its course, or else it will fail to strike it. But of this, which is the motion of projectiles, I shall have to speak more at length hereafter.

Force, then, always exerts itself in right lines and if motion results from that force it will be also in a right line. Whenever we require motion in a curve, a certain amount of power is lost by friction, in consequence of the constant tendency to recover the straight direction. To this fact is owing the failure of what are called rotatory steam engines, in which the steam is forced to act in a curved path. In the case of these engines the friction may be practically regarded as removed from the comparatively small surface of the crank pin to the larger circumference of the interior of the drum or chamber in which the steam is constrained to act. The constant expansive tendency of the steam increases this friction and consequent loss of power, so that a similar expenditure of fuel in rotatory engines does not affect so high a unit of work in the rotatory as in the reciprocating principle. In the case of a stone whirled round in a sling we find that the pressure of the stone outwards increases in proportion to the velocity with which it is whirled. If one end of the sling is let go, the stone instead of continuing to move in a circle flies off at a tangent to the circle described. Hence there is a constant pressure outwards, known as centrifugal force, which we shall treat of more at length when we speak of circular motion.

The right line in which a force moves is called its direction Thus, if I suspend a weight by a string, the string will point out the direction of a certain force acting upon it, which force is called gravity. This principle gives us one of the easiest practical methods of finding perpendicular and horizontal lines; it forms in fact the plumb level, which in some one or other of its forms is known to everybody and understood by everybody, as the embodiment of the idea that the direction of the force of gravity in the plummet is in the line occupied by the string which suspends it. We have here, however, more than one force. The action of gravity alone would cause motion, but the tension of the string opposes another force, and this tension is again counteracted by the resistance of the support. It is the ratio or proportion of forces, and not their quantity, which is to be considered in order to establish the condition of equilibrium. Thus it is evident that whether these weights in the last experiment be 10 oz. or 1000 oz., the block will still remain in equilibrium, provided the two weights be equal So likewise in any system, the amount of each individual force may be indefinitely increased without disturbing or in any way altering the equilibrium. But if one force be increased without increasing the others, the case of equilibrium becomes one of motion, and takes its place in Dynamics.

One force, then, is said to be equal to another when being opposed to it, it retains a point acted upon by each in equilibrium.

Two equal forces applied to the same material point, and acting in the same direction, constitute a double force, and three such forces a triple force.

When a force is applied to a body all the points or particles of which are immoveably connected with each other, it is obvious that one point cannot move without a corresponding change in all the others, and consequently a force applied to any point will have the same effect as if it were applied to any other point taken in the direction of that force. In other words, it is immaterial in what part of the line of direction the force is

applied. Again, to prove this experimentally, in applying force in pulling a line, it evidently has the same effect whether we hold the end, middle, or any other part of it. Again, if we suspend a piece of wood to a nail, and then suspend two weights to pegs in this wood, placed perpendicularly to each other and to the point of suspension, we shall find that we may move the point of suspension of the weights to any part of the line of direction without altering the position of the mass. We thus see that the effect of a force is the same at whatever point in its direction it is applied.

Our next business is to deduce the laws of equilibrium from these definitions, and to speak of the Composition and Resolution of Forces.

I just now stated that if two forces act upon a body in directions diametrically opposite and these forces are equal they will destroy each other's effects, and the body will be in a state of equilibrium. But if the forces are unequal, the greatest will preponderate, and the body will be tended to move by a force the intensity of which is equal to the difference between the two former. The same rule will apply to any number of forces. Now, when two forces acting upon a material point form between their lines of direction any angle, an equilibrium cannot exist. Thus, in this

Fig. 1.

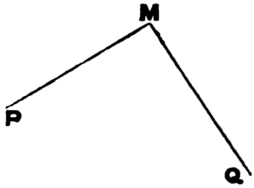
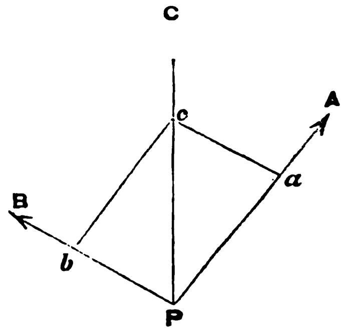


diagram (Fig. 1), let us suppose these two lines P and Q to represent the direction of two forces acting upon the point M. It will, I think, be evident that the body cannot be in equilibrium, because the forces are not opposed. To prove this experimentally we will suppose these two forces to be acting upon the point which I hold. While I thus continue to hold it there are three forces which oppose and counteract each other, and merely produce equilibrium, but when I remove my hand I leave two forces which act in an angular direction. The consequence is that motion results, which continues until the lines of direction are opposed to each other. We thus see that since an equilibrium cannot exist between two forces forming between them any angle, it follows that a pressure will be exerted, which, if no obstacle be interposed, will result in motion. This pressure was just now exerted on my finger, and we must now endeavour to ascertain its direction. Of the motion which we saw just now result I shall have to speak when I endeavour to demonstrate the laws of motion.

We wish, then, to ascertain the direction of the pressure of two or more forces acting at certain angles with each other. This problem is called that of the Composition of Forces, and consists in finding a force in direction and intensity which would produce the same effect as these combined and angular forces do. This force, when found, is called the Resultant, and the two or more original forces the Component Forces. This law is the foundation of all Statical inquiries; in fact, the principle runs through every ramification of the science, and we shall have frequently to recur to it, and, therefore, I shall endeavour to explain it as clearly as possible.

Fig. 2.



Let P be the point on which two forces act, and let their directions be represented by P A and P B. Let their separate amounts be seven and nine pounds or ounces, or any other unit. It is evident, as I just now proved, that motion would result in this system; but we wish to prevent motion and cause equilibrium by finding the amount and direction of a force which shall successfully oppose the other two. From the point P along the line of direction P A we take a length, P *a*, equal, to say, as many inches as there are units in the force acting in that direction. Also take P *b* in the other direction equal to the other force. Through *c* draw a line parallel to P *b*, and through *b* draw a line parallel to P A. These lines meet at *c*. Now draw the line from P to C. Now this figure represents a parallelogram, and is called the Parallelogram of Forces, and we shall find that if we take a third force in the direction of the diagonal P C, hang as many pounds or other units to it as there are inches in the diagonal, and oppose that force to the two original or component forces, that they will be balanced, and equilibrium will result.

This proposition is thus stated—"If two forces be represented in quantity and direction by the sides of a parallelogram, an equivalent force will be represented in quantity and direction by its diagonal." To illustrate this still further, if I suspend two weights over pulleys and hang a third weight upon any part of the string it will take some determinate position of rest. In this state it is evident that the last weight balances the two former. It acts in one direction, while the other two act in different directions. These two forces, then, are equivalent both in intensity and direction to a force equal to the larger weight acting upward; that is, if an equal weight to the larger one were caused to act in a line opposed to it, it would produce the same effect as the two smaller weights acting in different directions.

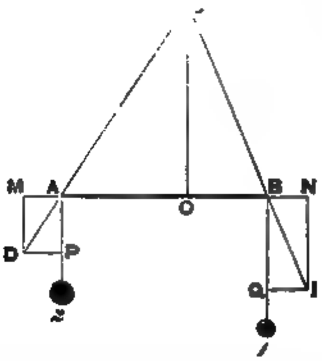
It often happens, however, that there are a number of forces in operation of various intensities, and acting in various directions. Thus we may have five or more forces all acting upon the same

point, but with different intensities and in different directions. The effect of these forces may be calculated in the same manner as the more simple combination, by taking two first, and finding a resultant to them, then with this resultant and the next force obtaining another, and so on till the whole are resolved by this successive application of the parallelogram of forces.

Forces also do not always exist in the same plane; they may act from different points, out of the plane, as the surface of a sphere. This case is also resolved by dividing them into pairs, inasmuch as any two forces always act in the same plane of direction.

Parallel forces act in parallel directions, and may be either equal or varying. We will suppose this line (Fig. 3) to represent a beam having two forces acting upon its opposite ends, respectively represented by the figures 1 and 2. Now, to suppose a case; let this beam be supported by two pillars or abutments at the ends, and we wish to remove these pillars for some purpose, and substitute one in their place. In order to do this safely, we must ascertain the point of the beam where the two forces equilibrate, and at this point the new pillar must be placed, or else the beam, with all that may be upon it, will be overbalanced and

Fig. 3.



thrown down. To ascertain this point geometrically and mechanically, we first imagine two other forces equal, and acting in opposite directions represented by the lines M A and B N. We measure in the line of direction of the original forces a distance to represent the proportion of each, as N I, M D, draw the lines I Q and P D to complete each parallelograms. Then draw the diagonal of each, and prolong both till they meet, in this case at the point C. A perpendicular let fall from this point will divide the line, representing the beam at the point of equilibrium, under which, if a support be placed, the beam with all that may rest upon it will be sustained. When many unequal forces are in operation they have to be resolved in the same manner as that which I described in the case of many angular forces, by taking two first and finding their resultant, taking that and the next force and finding a new resultant, and so on.

We may at once see the important nature of these problems which I have brought before you this evening, and consideration will show to us that they are some of the most important that can occupy the attention of the man of science, whether practical or theoretical. The architect, in the construction of buildings, has to consider the various pressures which will obtain in his edifice, and his skill will be shown in efficiently providing for and keeping those pressures in equilibrium in the simplest manner and at the smallest possible cost of materials. This part of Statics involves the strength of materials, such as timber and stone, and failure here may be attended with the most disastrous consequences. The practical engineer, also, in constructing machinery, has a number of strains and pressures to provide against in the framework of his engines, and he too will exhibit his practical and scientific skill in distributing his materials so as to render every part secure, without overloading or causing it to be unnecessarily expensive or clumsy. Strength does not necessarily consist in the presence of large masses of matter, whether metal, wood, or stone, but in the skilfully arranging and combining these in the directions of the disturbing forces. So that frequently a machine, engine, or building which absolutely weighs less, may be actually stronger than one more cumbrous and heavy. Empiricism prevails to an immense extent in every branch of practical science; and you will often find men largely engaged in various works absolutely ignorant of the first principles of their art—in fact, knowing nothing of the theoretical portion. Failures and disasters therefore often occur; and, indeed, it may justly be a subject of surprise that they are not much more frequent.

(To be Continued.)

ON THE PENDULUM.

Second Lecture.

Delivered by E. D. Johnson, Esq., F.R.A.S., *for the* Horological Institute, *at* Spafields Lecture Hall, *October* 16*th*, 1861.

Mr. Klaftenberger, V.P., in the Chair.

(Continued from page 60.)

Dr. Lardner more feasibly suggested a suspension spring to be formed thus (describing from drawing), then cut tapered both in thickness and form; this has been tested by permitting a clock to go without oil, and the arc of vibration to diminish to within one-tenth of a degree of the arc of escapement, and on comparison of this arc with two degrees on each side the perpendicular, carefully noted by transit observation in the same building, no perceptible error was noted in the

time of vibration. That experiment was made by a member of the Horological Institute, Mr. Langford of Bristol. On this board (referring to one suspended from the wall of the room), you may see a representation of the form of this suspension spring. It is tapered both in form and in thickness: that is to say, it is broader at the top than at the bottom, and thicker at the top than at the bottom, and is graduated by experiment, and by experiment alone can it ever be graduated. By means of the experience gained in this particular case, (the dimensions which as I said I can give you), the spring may be made nearly correct; but I doubt if it be possible to make a spring to any given pendulum without subsequently adjusting, by alteration of the shape or thickness to the particular weight and arc of vibration described.

The most recent of these contrivances for isochronizing a pendulum is Loseby's bridle, against which I see no valid argument or objection, and certainly there is no mechanical difficulty attending its application. It is true, I think, that it can be better applied than it was by the inventor, but it would still be only developing his original idea. It has this peculiar advantage, that it is adjustable to any extent. It is also very simple, and not liable to failure by lapse of time. It is composed of a loop, or stirrup of tempered steel wire, projecting from a brass mounting on the back of a case, and surrounding a pin on the rod of the pendulum, but without touching it except when the pendulum by its own motion gathers up the loop by means of the aforesaid pin, and bends by elongating the loop. This loop on change of motion of course exerts a certain amount of force as a spring. You will thus see that it is applicable to the acceleration of the long vibration without interfering with the short. This was exhibited in Hyde Park in 1851, but it certainly did not excite as much attention as its merits deserve. Applied as it was then, grave objection might have been taken to it, and no doubt it may be applied far more philosophically to the pendulum, because in its original form it was open to an objection in relation to the effect produced by impulse given to pendulums, to which I shall by and bye have to allude, and which is one of very grave importance. Any such alteration would not interfere with the principle, which I believe to be one of the best of all these that have ever been suggested as supplementary forms to achieve the equal vibration of pendulums.

I spoke last Wednesday evening on the property of conical pendulums, as a subject belonging to our art. I referred to the difference of the time as compared with the vibrating path of the ordinary pendulum. The latter an ordinary pendulum, constructed to and supposed to vibrate in a plane, has nevertheless a constant tendency to convert that plane into an ellipse, and consequently to approximate its time to that of the conical pendulum, because the circular or continuous motion always differs from the time shown as marked by the vibrating body, which has an accelerated and retarded motion, arriving at the point of rest and recommencing motion in the opposite direction, while the conical pendulum vibrating in a circular or eliptical path, has no point of rest, but its motion is constant, and, if circular, equable.

The first point to be considered is already done for us, happily, by the flat form of the suspension spring. But I want to call your attention to a fact that will have a bearing in other ways, as every mechanical man capable of keeping a pendulum in motion by mechanical impulse, knows. Let us suppose that (referring to diagram on board) to be the rod of a pendulum; you will see directly that the only point to supply the impulse is exactly in a centre line passing through the centre of gravity of the whole mass of the pendulum. The reason is this, that in pushing a body we easily lose control over the direction of the motion. Suppose these to be a number of pieces of sticks; to make the experiment more satisfactory, imagine this a little round;—how long do you suppose that by pushing these you would have a straight line? The slightest particle of dust coming in their way, or the least tremor, and they immediately break from the straight line and go zig-zag all manner of ways. Thus the moment the departure from the line takes place, the effect of the push will be to increase that inclination. But supposing you have got each of these pieces so arranged as to be attached by a thread one to another; now pull them, and you see that the converse of the proposition takes place. If anything deranges them, the action of the pull draws them back to the proper path again. Its effect is not to derange them, but to correct them. Here again. you, have an application of the same principle (referring to the diagram of the impulse, part of a pendulum) at any point other than the centre, there will be more of push and less of pull than if the impulse were perfectly central, and the tendency to set up the zig-zag motion will be increased unnecessarily, and the natural time of the pendulum be interfered with, and follow all the irregularities of the maintaining force.

In consequence of this vermicular motion, the pendulum will have to travel a larger space or longer path without any difference of the fall. This is a mechanical defect, and one that should never occur; but which is so common as a defect, that I advise you, as an experiment, to take the trouble to attach a little bit of common-looking glass to the side of any pendulum, whence you can take a beam of reflected light which will give you the means of magnifying the effect, and you will see that whereas it is scarcely recognizable by the pendulum itself, I pledge you my word that you will scarcely find one pendulum in one hundred that does not at once show that fatal defect. It may go tolerably well in despite of it, but there is no doubt that this is the cause which vitiates the proper action in many.

The next point that I want to call your attention to, is one of importance in consequence of the application of that principle, namely, the necessity for preserving the natural motion of the pendulum; that is, the necessity for keeping the planes of vibration of the pendulum and the clock-plate parallel, or else of supplying something that shall supersede that necessity. Supposing that (referring to diagram) to be the back-plate of a clock, and everything properly arranged; supposing the arbor of the verge or pallet axis to be absolutely

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, From a press of matter the Table of Rates by J. Hartnup, Esq., was unavoidably omitted this month.—Ed. H. J.

OBITUARY.—We regret to announce the Death of Mr. BREESE, Sen., which took place February 1, 1662. His talents were of high order both as an Horologist and Mathematician. He was the first Secretary of the British Horological Institute and contributed valuable articles to the Journal.—Ed. H.J.

ing Bodies.

„ 25 ... „ 8.—Gravitation (Second Lecture) Projectiles—The Pendulum—Effects of Gravitation on the Heavenly Bodies.

Division Third.

March 11 ... Lecture 9.—Mechanical Powers: Lever, Wheel and Axle.

„ 18 ... „ 10.—Pulley—Inclined Plane—Wedge—Screw.

METEOROLOGICAL OBSERVATIONS,

Taken at 9 A.M., JANUARY 1862.

REMARKS.

The general state of the weather is recorded blue sky; o, , mist or haze; rain; rr, heavy

The highest reading of the barometer was 30·48, at 11 a.m. on the 2nd; and the lowest 29·33, at 1 p.m., on the 11th; hence the greatest range was 1·15 inches.

During the whole of the 11th a violent gale prevailed from SW, veering to W, and to NNW.

On the 24th there was a moderate gale from SW to W.

Between the 25th and 29th, the wind veered from SW to W, N, E, S, and to SW.

On the 31st there was a moderate gale from W to NW.

Rain fell on 19 days, during about 88 was

ie 9 a.m. wind directions to ›ints, it appears the N wind blew on 5, E on 4, S on 11, and W on 11 days.

R. S.

EQUATION OF TIME TABLE

FOR MARCH, 1862.

Day of the Week.	Day of Month	At Apparent Noon. — Equation of Time to be *added* to Apparent Time.	Difference for One Hour.	At Mean Noon. — Equation of Time to be *subtracted* from Mean Time
		m. s.	s.	m. s
Sat...	1	12 34·87	0·504	12 34·97
Sun...	2	12 22·77	0·525	12 22·88
Mon..	3	12 10·17	0·545	12 10·28
Tues..	4	11 57·09	0·564	11 57·21
Wed..	5	11 43·55	0·583	11 43·67
Thurs.	6	11 29·56	0·601	11 29·68
Frid..	7	11 15·14	0·618	11 15·26
Sat...	8	11 0·31	0·634	11 0·43
Sun...	9	10 45·09	0·650	10 45·21
Mon..	10	10 29·50	0·664	10 29·62
Tues..	11	10 13·55	0·678	10 13·67
Wed..	12	9 57·27	0·691	9 57·39
Thurs.	13	9 40·69	0·703	9 40·8[illegible]
Fri...	[illegible]	9 23·83	0·713	9 23·94
Sat...	15	9 6·70	0·723	9 6·81
Sun...	16	8 49·34	0·732	8 49·45
Mon..	17	8 31·77	0·740	8 31·88
Tues..	[illegible]	8 14·01	0·747	8 14·11
Wed..	[illegible]	7 56·09	0·753	7 56·19
Thurs.	20	7 38·03	0·757	7 38·13
Frid..	21	7 19·86	0·761	7 19·96
Sat...	22	7 1·59	0·764	7 1·68
Sun...	23	6 43·25	0·767	6 43·33
Mon..	[illegible]	6 24·85	0·768	6 24·93
Tues..	25	6 6·41	0·768	6 6·49
Wed..	[illegible]	5 47·97	0·768	5 48·05
Thurs.	27	5 29·54	0·768	5 29·61
Fri...	28	5 11·11	0·766	5 11·18
Sat....	29	4 52·73	0·763	4 52·80
Sun...	[illegible]	4 34·41	0·760	4 34·47
Mon..	31	4 16·16	0·757	4 16·22

TO *&c.*

N.B.– the ... Secretar E.C. before the 23d of the month.

All for this Journal should be ad- the Office, 35, Northampton Square, Clerkenwell.

London by P.

THE BRITISH HOROLOGICAL INSTITUTE.

THE ANNUAL DINNER.

(*Continued from page 77.*)

Mr. V. Knight.—I rise with very great pleasure, although I must say mixed with some pain, to propose the next toast; pleasure as respects the individual I have to speak of, and pain from fear of my not being able to do justice to the toast I am about to propose. Our excellent friend, the Lord Mayor, who has performed his duties in a manner which must have been acceptable, not only to every citizen of London, but to every inhabitant of that city, has with very great kindness acquiesced in the request made to him to take the chair this evening; and when we consider the numerous calls which his Lordship and the sheriffs have upon them, undoubtedly we are under great obligation to them for their attendance upon this occasion. Whether we view the Lord Mayor in his magisterial capacity, or look at the benevolent disposition he has evinced in his personal character, or at his unbounded exercise of that hospitality for which the city of London is so proverbial, not only in the first but in the second year of his mayoralty—I think that you will agree with me, that he is really an honour to this great metropolis. I am sure that you will all feel with me, that with the greatest cordiality of feeling towards his lordship, we should most sincerely thank him for the great favour he has done us upon this occasion, and that you will join with me in drinking his health, with three times three cheers.

The toast was drank with loud applause.

The Lord Mayor, in responding to it, said,—Mr. President and Gentlemen: when I was invited to preside at your banquet this evening, I felt that a high honour was conferred upon me, and in accepting the invitation I believed that I was simply taking advantage of a great opportunity that was afforded to me. I know of nothing which could have given me more pleasure than to have been asked to preside over a company of such a scientific character as that which I have now the honour of addressing. The President of your Institute has kindly alluded to my conduct in the civic chair; all that I can say in reply to his observations is, that I have humbly, earnestly, and anxiously endeavoured to do my duty in the position in which I have been placed, always doubting and apprehensive, yet trying to do my best; never expecting to accomplish any very great things, but merely meeting exigencies as they have arisen as well as I was able to do. That is a course of conduct which has been, so to speak, forced upon me by my nature throughont my whole existence; never imagining that I should be a great man, nor expecting ever to do great things, but always endeavouring to do what I have to perform as well as I could. If you are pleased to think that my coming here this evening is of any advantage to this Institution, it is a great gratification to me. All that I have now to say, is that I am deeply grateful to you for the manner in which you have been pleased to receive me.

Mr. Common Councilman Connell, said—My Lord Mayor, Mr. President, and Gentlemen:—The duty with which I have been entrusted is that of offering to your notice the health of, unfortunately, only one of two gentlemen who were expected to be present, namely, the Sheriffs of London. You have drank with great enthusiasm the health of the Right Honourable the Lord Mayor, as the centre of that municipality in which the others hold such prominent positions, and I am sure that you will most cordially drink the health of those two satellities who usually attend his lordship in public. I am certain that you will deeply sympathize with the absent gentleman, because from what I know of my friend Mr. Sheriff Twentyman, I am sure that he would have been here to-night had not very pressing and unfortunate circumstances prevented his doing so. When I tell you that he has met with a severe domestic affliction, that his wife has been taken exceedingly ill, and that a consultation of physicians has been held upon her case, every married man present, as well as every single one, will sympathize with him, and exonerate him from any imputation of want of appreciation of the British Horological Institute, because he is not present at this dinner. With regard to the other Sheriff, Mr. Cockerell, I own it is difficult to speak of him, because it is always unpleasant to refer to a personal friend before his face; but I am sure that he is so well-known, and so fully appreciated as an excellent man of business and an efficient member of the corporation, that you will most heartly welcome him here to-night. I believe that he is present not only officially as Sheriff of London, but also to express his individual sympathy with the objects of the Institute; because where a man has been successful in his own line of business, he cannot fail to be rejoiced to have an opportunity to assist by his presence in promoting the success of another business, such as our own, which is labouring to retrieve itself from some of the difficulties under which it lies at the present time. I am, therefore, sure that we all feel much indebted to Mr. Sheriff Cockerell for coming here to-night. Had it fallen to my province, I might have wished to say a word or two with reference to our own trade; but as that subject will be dwelt upon by others, I will not diverge from the toast which has been entrusted to me, further than to say that I trust that the Horological Institute will effect that which the trade is so much in need of, by introducing that scientific arrangement of the manufacture which it demands, and which must be had if British watch makers are to maintain their position as pre-eminently the horologists of the world. There is one branch of the business in which we still stand unequalled, if we do not hold that pre-eminence in all; and I hope that this is the beginning of a better order of things, and that the Horological Institute will work out that which I

am sure its members desire, and which I venture to hope that they deserve, namely, the elevation of the English makers to the position which they ought to occupy as the first watch makers in the world. Nobody would more rejoice than the Sheriffs would do to find that their presence along with the Lord Mayor here to-day has tended to produce that effect. We thank them sincerely for having done us the honour of being present to support the Right Honourable the Lord Mayor, and I am confident that you will most cheerfully award to Mr. Sheriff Cockerell that meed of praise and thanks to which he is so justly entitled.

The toast was drank with applause.

Mr. Sheriff Cockerell.—My Lord Mayor, Mr. President, Mr. Common Councilman Connell, and Gentlemen,—I have come here to meet you with considerable pleasure, mixed, as your President remarked, with some degree of pain. I thank you on behalf of my colleague as well as of myself, for the kind reception you have given to our names, and for the way in which you have received the proposition of my friend, Mr. Connell, to drink the healths of the Sheriffs of London. I know that it was the intention of Mr. Sheriff Twentyman to have been present on this occasion. Indeed he even sent to me in the middle of this day, for further particulars as to the time of your meeting and so forth; but I fear that the result of that consultation of physicians which has been spoken of, has been such as to prevent him from carrying out his intention of joining us to-night. On his behalf, therefore, as well as on my own, I thank you for the kind reception you have given to us. Gentlemen, the Sheriffs of London have been referred to as having some sympathy with your body, and with the objects of your association. I trust and believe that they have that sympathy. It affords us considerable pleasure to come among you. It is no small gratification to us to be instrumental in forwarding the objects of this Institute. I am sure that I speak the language of my colleague as well as my own, when I say that it will be our happiness to do so. We are the Sheriffs of Middlesex as well as of London; and the centre —the very heart—of that county seems to me to be Clerkenwell, in which district this Institute is situated. When I see around me such a number of intelligent faces, of men engaged in so important a business, with which I personally have always felt the deepest interest, I could not feel otherwise than pleased to be privileged to be present at such a gathering. I believe that the vocation for which I was constitutionally designed was that of a mechanic, rather than for the one in which I am engaged. I should have been a much happier man if my lot had been cast in a certain occupation which required mechanical ingenuity, in which my hand and my brain could have worked together. The great difficulty of life is to know our place and position in it; and if in that position we can do anything to benefit the body to which we belong, we must feel great satisfaction in having the opportunity of doing so. The Lord Mayor and myself have attended a meeting of the Ragged School Union to-day. I only mention the circumstance to avail myself of the very important word "union" in the name of that society. I think that all the trades in London should be united. The great Corporation of the City of London and the public companies originated those business unions. If the watch and clock makers will only be united, and take every opportunity of forwarding the interests of the businesses in which they are engaged, they will be much benefited by so doing. I do not see why any man in England should object to such co-operation. I do not say that foreigners should be excluded from them. The proper plan is to take from them all that can benefit us, and to impart to them in return all that can do them good. It would be improper in me to detain you longer. I trust that you will pardon the suggestion that I have thrown out. It is a principle the importance of which has impressed itself very seriously on the minds of the members of another trade. In the sharp and fierce competition for manufacturing and commercial pre-eminence now going on, such union can do you no harm. Endeavour as far as you can to be united, for there can be no doubt that union will tend to your individual and collective strength.

The Lord Mayor:—Gentlemen, I should have unmixed pleasure in proposing what I deem to be the toast of the evening, were I not a little apprehensive that from my ignorance of the subject, and also from its great importance, I may fall short of what ought to be said upon such an occasion. I feel that this is no ordinary gathering; I am sensible that I am addressing one hundred gentlemen, who without exception are men of mark; that the Horological Institute comprises men whose whole lives have been devoted not merely to work but to study. In the productions of their manipulation they have attained to a high order of mechanical excellence. An ordinary machine can in no way be compared to a watch. The necessity for perfect exactness—the very embodiment of truth—which is required, necessitates the exercise of thought in the mind of the maker whilst he carries on his mechanical operations. The very name of the maker is significant of intelligence — "*Horo-logist*"—a maker of machines to mark the hours. It is not merely that watch makers are men who make wheels, and put them together, but they produce most wonderful and delicate instruments to enable the world to be exact in their business proceedings. Probably I have more opportunity of judging of the great necessity for such exactness, and of its value in life, than most persons have, from the fact that I happen to occupy the largest house in a remote village in Hampshire, outside of which, for the convenience of the neighbourhood, I have caused to be put up a turret clock. My residence is within a few miles of a railway station, and if my clock happens to be a minute too slow it may mislead a passenger, and cause him to lose his train. People laugh at a poor fellow who arrives at a station panting and out of breath, and who, after all his exertion, finds that he is too late to proceed on the journey; but yet it is not a laughing matter, because the consequences to an individual of such a loss may be very serious. I therefore feel it to be of the greatest importance to society that it should be furnished with instruments which will keep correct time. If you walk up and down Cornhill, you see people on one side and on the other looking up at the great clock of

the Royal Exchange. Whilst you are making such observations the mind cannot help being impressed with the great value of an instrument for the correct measurement of time. With ordinary mechanics, such as blacksmiths, carpenters, and bricklayers, if their work satisfies the eye and is sound, it is quite sufficient for every purpose. But that is not enough in your "art," I was going to call it, and I think I may fairly do so, for the manufacture of such scientific mechanism is indeed an art. There is not another word in the English language sufficiently comprehensive to express the meaning contained in the word "horology." Watch work must be not merely well done, but be calculated to such a nicety as the mind can hardly comprehend. I have no doubt that there are in this room gentlemen who have assisted in making chronometers which have afterwards gone round the world, and come back again without having varied in the slightest degree. I know that I am touching upon ground which I do not understand in detail. I do not know how near to absolutely correct time a chronometer can go round the world. I believe it is something like a minute or so; but this I do know, that you are endeavouring to get that degree of perfection which will enable you to send a chronometer round the world half-a-dozen times without any variation of time. That is the degree of excellence which you are striving to attain unto, and although you may not altogether achieve it, it is a grand thing to arrive at something approaching to that result. I rejoice in being placed in the honourable position of presiding here to-night, not merely on my own account, because I know nothing of that wonderful art with which you are all so well acquainted, but because of the civic position I hold, which is the reason why you have asked me to come here. It is one of the happy accidents, or perhaps I should say "incidents," of the office I now fill, that the Lord Mayor is called upon to be placed in connection with things which confer a great amount of honour upon him for the time being. That is my case to-night. I understand that your Institute has not been established for any pecuniary or selfish object, but for the interchange and communication of ideas between men of various minds, engaged in one common object; to give them an opportunity of imparting to each other discoveries which shall tend to raise the art which they are carrying on to the greatest degree of perfection; not for the promotion of individual interests, but for the good and glory of mankind, I think I may say that it would be to the glory of mankind if anything could be done by man, who is himself but an imperfect creature, which should so far imitate the works of the almighty as to produce something which is almost organic; to make an instrument go with truth and accuracy, I was going to say to the end of time, but at all events for a very lengthened period. It would be a glorious thing for this Institute to be in any way instrumental in promoting such objects as these. There is no doubt that such an association must succeed to a certain extent. When I say "certain," perhaps I should say "uncertain," extent; but still I am confident that you will attain to a great degress of success. It is impossible that some hundreds of people, all engaged in one common object, should meet together, and reciprocally interchange their ideas on the art on which they are engaged, without great and beneficial results. I beg to assure you, Mr. President and Gentlemen, that if I had had time during the last few days to have studied the subject, I might have said all that I have endeavoured to say, perhaps, in a quarter of the time I have trespassed upon your attention; but I am much occupied in various other ways, and I have had very little opportunity to think about the details of the working of this Institute; but at the same time I beg to assure you that I feel its importance. When I think of its object, and what it may arrive at, I feel that it is indeed an association which ought to be cherished. It is with that notion that I ask you to charge your glasses, and rise and drink "Prosperity to the British Horological Institute," coupled with the names of Mr. Valentine Knight and Mr. J. C. Webb.

The toast was drank with great enthusiasm.

Mr. Knight.—My Lord Mayor and Gentlemen, I think that you will agree with me that I may fairly congratulate our excellent friend, the Right Hon. the Lord Mayor, on his first appearance in the horological world. We have ascertained beyond all dispute that he has a mechanical mind, a scientific genius, and a philanthropical heart. I can only repeat how much we all feel indebted to him personally, and I say so with the utmost sincerity. The citizens of London esteem him as they ought to do. They have only made one blunder, and that was in not returning him as their member; but it is never too late to mend. I hold the Horological Institute to be one of the finest in the metropolis. I think that it is almost a disgrace, not only to the trade but to human nature generally, that it was not instituted years ago. In Paris and Geneva such associations have been established, and they are there flourishing to a very high degree. When we look at the value of time —as our friend the Lord Mayor has so beautifully said—I think that we must come to the conclusion that a good watch is one of the best companions which a man can have. When, however, we go beyond that, to the chronometer, and perceive its immense value in connection with the compass, I ask where would the commerce of this great metropolis be if it was not for that valuable machine? The gentlemen whom I now address are trying a thousand plans to bring that instrument to the greatest degree of accuracy, and so to render it more serviceable to mankind. I am sure that there is no man whose attention is drawn to the great advantage which the world derives from the watch who would hesitate for one moment to subscribe to this Institute. I trust that although it is young in years at present, it will grow into maturity, and that we may some of these days see it flourish pre-eminently. I hope that it will get the patronage of the trade, the members of which are bound in duty to support it, but that it will receive that assistance from every rank of society which I believe it is entitled to at their hands. Gentlemen, I am sorry to say that the funds of the Institute are not in a flourishing condition, and therefore I trust that persons engaged in the manufacture will in the first instance set an example of liberality which may be followed by those who are

not engaged in it, so that this Institute shall never be allowed to fall to the ground. In the list of toasts it is stated that Mr. Knight is to respond to that of the British Horological Institute, and then will follow the Subscription List. I believe that upon the present occasion the subject of funds is very important. I know that the times have been hard, and that there has been a special amount of depression in the watch trade; but still it is a sad heart that never rejoices; and when we are met to rejoice and enjoy ourselves, I think we should do a little in the way of contribution to such an association as this. I will not call it a "charity," because we demur to the correctness of the application of that elemosynary phrase to it. Gentlemen, I am sure that this table will set an example of liberality, and I hope that there is no person in the room who will fail to subscribe on the present occasion. I call upon you all, whatever you give, to give it heartily, and to take care that you do not contribute too little.

Mr. J. C. Webb.—My Lord Mayor, Mr. President, and Gentlemen, I thank you for the honour you have done me in connecting my name with this toast. I was perfectly unprepared to respond to it. I could have understood my being required to speak in the capacity of treasurer; but to have my name coupled with that of Mr. Valentine Knight is an honour that I never looked for. Whatever I could say after Mr. Knight must be of very inferior importance. I will, however, say a word for the Institute if I have none to utter for myself. I am perfectly satisfied with the progress that it has made; I regret, however, to say that there are many members of the trade who have not put their shoulders to the wheel in order to promote its interests by joining the Institute. There are some associations which men ought to consider it an honour to belong to, and the British Horological Institute is one of them. We have arrears to fetch up as a trade, but by increasing our exertions we may succeed in liquidating them. The Institute is now so firmly planted that no storm can uproot it. It is not my business to speak upon the subject of finances, or else I might have made a few observations upon that point. I cannot sit down without expressing the pleasure I feel at seeing the Lord Mayor in the chair. He has set a worthy example, which I hope will be followed by many of his successors.

Mr. Charles Frodsham.—The toast I rise to propose is one upon which much could be said, but I am not prepared, and I am but little gifted to do so. I am not like the Lord Mayor, always well prepared to speak. The toast with which I have been entrusted is, "The President, Vice-Presidents, Trustees, and Council of the British Horological Institute," coupled with the names of Mr. Valentine Knight and Mr. E. D. Johnson. It is quite impossible that an Institution of this kind could exist without such officers as those of President and Vice-President. It is very agreeable to see a gentleman in the position of Mr. Valentine Knight, who, having retired from a business, has not forgotten those belonging to it whom he has left behind him. There are some gentlemen who have retired from business who quite forget those with whom they were formerly associated in trade; but Mr. Valentine Knight takes especial pleasure in finding occasions upon which to associate himself with the members of his old business. On the last occasion when we met in this hall, to promote the interests of an association established for the benefit of our less fortunate brethen, he sat upon the right hand of the Lord Mayor, and he by his eloquence contributed to raise a very handsome subscription, I think of something like £400, collected not in prosperous times, or from thriving men, but from the great body of watch makers at a time when trade was bad; a fact which shows that scientific men in all ages have been men of good feeling. I do not think there is any body amongst whom there exists a greater share of scientific knowledge than amongst the watch makers. Mr. Connell said that the period had come when we must start forward; why? Because we shall go back, and lose that high position which we possess as chronometer makers throughout the length and breadth of the world, unless we take steps to go forward, and make our knowledge available for the benefit of the trade. There is a mass of experience existing among the marine chronometer and watch makers, which if only brought forward and made public property would be of immense advantage to them. If the English watch makers would take a new start from to-day, or from the Great Exhibition of 1862, they might become in every part of the manufacture as great and eminent over the world as they are now for the making of the marine chronometer. How gratifying it must be to many gentlemen present, to know that the thousands of ships at sea, freighted with human life &c. are relying almost entirely upon the accuracy of their English chronometers for their safety. I trust this confidence will never be forfeited; our anchor of Hope must be in quality not in quantity. Whatever nation possesses ships there you find the English chronometer among them. It is held in the greatest reputation. It has been brought, I may say, as near to perfection as human nature can bring it. If you go into an observatory, English or foreign, where men are trying to discover yet more simple rules to guide the navigator, there you find that the standard of time is the English astronomical clock or the English marine chronometer. Why not bring the knowledge you possess and make it of the greatest practical commercial value? I am quite sure that if we resolve to do this it can be done; that we may take a new lease of the trade from this time, and that it will be found that nothing can withstand English ingenuity and industry. I never can conceive that the Englishman cannot compete with the foreigner in any branch of mechanics. We who have from time immemorial been celebrated as the most able mechanics and the best manufacturers! It is said, I know, that we work at a disadvantage as regards the price of living. Before this society was established, watch makers were so wrapped up in their pursuits that really they had not time to meet and discuss what they were doing. Nor was there a proper place to receive or make known the experiments of able men willing to give information; but it is time that the great mass of experience is given up to the Institution, put into working shape, and made the common property of all. We are all deeply indebted ourselves to the

inventions of our past great masters, namely, Harrison, Graham, Ellicot, Mudge, Arnold, Earnshaw, and a host of others whose inventions we are daily using. In common justice to society are we not bound to throw our mite into the common stock of knowledge. It is said that people like a thin watch. Well, we used to make them so, but what was the case years ago? The public taste was just the reverse. Put anything but a thick watch into an Englishman's pocket, and it would not have been acceptable to him. I recollect many years ago asking a gentleman how he liked a watch I had made for him. He replied, "If I am to judge of it by its going I like it very much; but it is quite a lady's watch." I then made him a large one, with which he was pleased. It is not that we cannot make small watches. Formerly we made some of the smallest ones, but the fashion changed. Amongst foreigners the Swiss are the watch makers; there are no watches manufactured now in France. We have no fear of foreigners; why should we have? They are very ingenious men. For my part I am ready to pay them the highest compliment for their worth. They always admit that in the finest work they cannot compete with us, such as in marine chronometers and astronomical clocks. But the Swiss makers are exceedingly clever, and show a greater commercial spirit than our manufacturers do. It has been said that the English watch maker is too professional, and too little a man of business. That is a great fact. We have been so wrapped up in obtaining a high reputation that we are ready to swamp anything for that. I have known one foreign maker who manufactured 2000 watches a month; but then he had sons in China and in other parts of the world to play the merchant. That is not the case with the English watch maker; he is too professional. He will not send to Japan, to China, and to various parts of the world, to find a market for his watches. I have great pleasure in proposing to you the toast of the Officers of the Institution, coupling with it the names of Mr. Valentine Knight and Mr. E. D. Johnson. With regard to Mr. Johnson, one of the Vice-Presidents, whose name is coupled with this toast, I have much pleasure in bearing my testimony to the extreme zeal and ability he has displayed in forwarding the interests of the Institute. (Cheers.) Gentlemen, let us drink the health of our officers with three times three hearty cheers.

The toast was drank with lond applause.

Mr. Valentine Knight:—My Lord Mayor, Mr. Frodsham, and Gentlemen, I think you have had enough this evening of Mr. Valentine Knight, but of course I must respond to the toast. I can only say that it affords me very great pleasure to promote the interests of this Institute. I have spent a very large portion of my time in Clerkenwell, where I was prosperous enough to retire from it. Although I have given up business for many years, I should be ashamed of myself if I ever turned my back on the old parish; I allude more particularly to the watch trade. But I am quite sure that when we have amongst our horologists such men as Frodsham, Cole, Jones, Hislop, Johnson, and many others, this society never can, and never will—I was going to add never shall—fail. I trust I may meet you for many years as its President. Having said this much, and as I know the eloquence of my excellent friend Mr. Johnson, I will say no more, being of opinion that it is the duty of the youngest officer included in the toast to do credit to it.

(To be Continued.)

MECHANICS.

Third Lecture delivered to the British Horological Institute.

By W. Hislop, Esq., F.R.A.S., Hon. Sec.

December 17th, 1861.

(Continued from page 83.)

We now come to consider the Centre of Gravity, and its properties.

"Gravity" is a term employed to denote that force, or agency, by which every material particle is urged towards the surface of the earth as soon as it is left unsupported. In consequence of this tendency all bodies fall towards the earth, and if prevented by other bodies from doing so, they exert a pressure on these latter. It is a force which constantly acts upon all bodies, under all circumstances, and, therefore, considerably modifies those circumstances.

Of the general phenomena afforded by Gravitation we shall have to speak hereafter, but it may be necessary to define Gravitation as an attraction exerted by all bodies in a greater or less degree according to their size and volume. The earth attracts all terrestial bodies according to certain laws, and is itself attracted by them. It is itself made up of smaller particles, and therefore Gravitation is the combined operation of all parts of the globe, which being nearly spherical, the result may be represented as if the attraction acted only from the centre. As the action of gravity is in a direction perpendicular to the earth's surface,

different parts of the body will pass through this centre required.

These methods, however, suppose the body to be a plane, and the points that we have found are only on its surface. They are therefore strictly speaking, not the centres of gravity, but the extremities of a perpendicular line in which the centres of gravity lie. This centre is generally within the solid matter of the body, except in the case of a ring, in which the centre is the axis of a cylinder of which the ring is a part, and also in other examples. If, however, we could pierce the dimensions of a body by straight lines, the centre of gravity of any body, whatever be its figure, could be found experimentally by the same process. If it be successively suspended by several points, and pierced by straight lines, in each case passing in a vertical direction through the point of suspension, it would be found that however numerous these lines might be, they would all intersect in one point, which would be the centre of gravity of a body.

Having thus defined and described the Centre of Gravity, we must now advert to some of its properties, and some of the phenomena which arise from, and are dependent upon the existence of such a centre.

If the centre of gravity is supported by any means whatever, then the body will be at rest, but if on the contrary, this body be not supported, the body will incline to that direction in which its centre of gravity is. Now if the centre of gravity be placed in the highest position, which the circumstances under which the body is placed will permit, as in *fig.* 5, it will remain at rest so long as it is perfectly undisturbed, but the slightest movement will cause it to return to the lowest position. Now of these two positions, in which it is possible for the body to remain at rest, the former is called unstable, and the latter stable equilibrium; and on this simple fact the steady or unsteady position of all bodies depends, besides a great number of modifications, which present themselves in every day life, either independently of our arrangements, or by our own contrivance, though almost without reflecting on the reason of our acting.

The centre of gravity may thus be supported in three ways, either by that centre itself, or by some point above or below it. If the body be supported by that centre itself, it can revolve at pleasure around this point, as in the case of wheels, whose centre of gravity lies in their axis, which, is supported by the socket in which it turns. Even those hollow or other formed bodies, whose centre of gravity is not contained within their volume may yet be supported by it, if any solid be connected with them, so as to pass through the centre of gravity, and the support be applied to that point. In like manner, if two knives be stuck at any angle in a piece of wood or cork, the whole may be balanced on the rim of a glass.

If the body be supported above its centre of gravity, as in the case of a pendulum, it is said to be suspended, and if then it be free to move, the body will not be brought into a state of rest until the centre of gravity has attained the lowest possible position beneath the point of suspension. This is a case of stable equilibrium, because although the body is disturbed, it returns to its original position of rest.

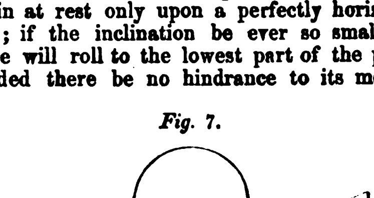
The body may be supported beneath its centre of gravity, and then it will remain at rest so long as the line of direction in which the terrestrial attraction acts upon this point, is supported. Thus if a body be supported on a point, and that point be in the line of direction, the body will be in a state of rest, but the smallest movement or the slightest deviation of the centre of gravity from its place would overthrow the body.

These cases belong to the unstable equilibrium class, and hence we may understand the reason of fixing the moveable handles of a vessel of any kind at its upper part, in order that the point of suspension may be always above the centre of gravity. If the handle be fixed too low, the vessel will be always liable to be overset, unless there be sufficient friction to sustain it in its proper position. In the other case, the handle is fixed considerably above the centre of gravity, consequently the vessel is stable.

A body of an oval form, as an egg, placed on a horizontal plane, is capable of a stable equilibrium, when it rests on its side, and of a tottering equilibrium, when it stands on the extremity of its greater axis. Again, if we place any body upon a plane, its stability will be determined by the position of the line of direction with respect to the base. If now, taking a certain point as the centre of gravity, we find that the line of direction falls within the base, the whole force or weight may be conceived as acting at that centre of gravity, and that force is supported or resisted by the plane on which the block stands and equilibrium results. But if the line of direction fall without the base, matters will be different. The force of gravity will now act upon the body, so as to make it turn over the edge and fall upon the side.

Many circumstances with which we are familiar depend upon these facts. A sphere or ball is supported upon a single point, but the centre of gravity being equally distant from all parts of the surface, as soon as the body is disturbed from one point on which it may rest another instantly supports it. It is owing to this fact, that spheres or balls are so easily moved; equilibrium being easily disturbed, and the more easily as the body is of a more accurate form. A sphere, however, can remain at rest only upon a perfectly horizontal plane; if the inclination be ever so small, the sphere will roll to the lowest part of the plane, provided there be no hindrance to its motion.

Fig. 7.

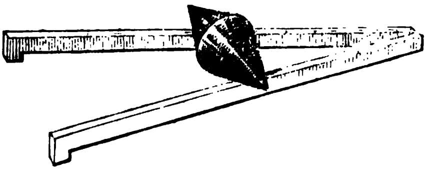


The reason of this fact is shown in *fig.* 7. Let the circle represent the sphere, and the line the plane, and the vertical line, the line of direction of the force of gravity. You observe that this line falls before the point of support, and as we have before shown that when this is the case, the body

must turn over, so in this case, the ball ceases to be balanced, and turns in a downward direction till it reaches a position where it will be in equilibrium.

This is a law so common and evident, that its effects are incorporated with our ideas as matters of course; but I have here an apparatus consisting of an inclined plane upon which, if this double cone be placed it will run towards the higher end; thus apparently reversing the laws of nature, and disturbing the smooth current of our percep-

Fig. 8.



tions. This ascent is, however, only apparent. If you watch the centre of the cone, which coincides with the centre of gravity, you will find that it descends; the stationary plane being opposed by a rolling plane or wedge of superior inclination formed by the surface of the cone. The sides of the fixed plane being placed at an angle, the body is free to place itself as near as possible to the grand centre of gravitation.

On the foregoing principle depends the following experiment. I have here, a plate of glass, and a capsule or watch glass. I place the former in an inclined position, and putting a drop of water on the exterior centre of the latter, I place it upon the inclined glass plate. It remains stationary, the water preventing it sliding downwards; if now I raise one side by pressing on the opposite, and the centre of gravity of the glass becomes thus a little elevated, for want of support, it will fall towards the base of the plane, thus generating a rotatory motion in the glass, which continues until it reaches some obstruction or falls off the edge.

I have stated that a sphere will remain at rest only on a horizontal plane—this is true, only when the centre of form coincides with the centre of gravity. For instance, take this ring as representing a section of a sphere; it remains at rest because these two centres coincide. In this case, however, the centre of gravity is considerably towards one side, and therefore it will remain at rest only when that centre is beneath the centre of its circumference. If therefore this body be placed on an inclined plane, it will arrange itself so that the centre falls within the base, and then it will stand at rest, and if the centre of gravity be placed above the point of support, the body will turn and ascend the plane until it finds its own proper position of equilibrium. If, as in another case, the centre of gravity be kept in advance of the line of direction, by the action of a spring, the body will continue to move, and even to ascend a plane till the force of the spring is exhausted.

There is a curious piece of mechanism occasionally seen, purporting to be a timekeeper, consisting of a circular plate of glass on which the hours are inserted, as on an ordinary dial, and having a gilded arrow in the centre which should point to the hour without any visible means of motion. One method of effecting this is by placing a small movement in the part of the arrow representing the feather which shall regularly move a weight nearer to or farther from the point on which the whole system turns. When at its greatest distance from that centre the feather end being the heaviest will descend till the centre of gravity comes under the point of suspension. The weight then gradually returns to the other side, meanwhile the feather end rises until it is directly over the centre, when the weight again commences to recede.

In general, the higher the centre of gravity is, compared with the extent of its base, the more easily will it be overturned. Every body therefore stands more securely, the lower its centre of gravity, the wider its base, and the greater its weight.

Fig. 9.

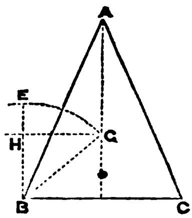
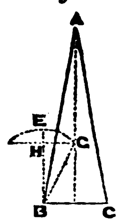


Fig. 10.



Now let A B C, *fig.* 9, represent a body placed upon a plane, and let G be the centre of gravity. In order to turn this body over it will be necessary to lift this edge of the plane to such a height that the point G may be carried through the arc G E beyond the perpendicular E H. Now let us suppose that by placing a load upon this body we raise the centre of gravity to G, *fig.* 10, it will now only be necessary to raise this centre through the arc G E, obviously a smaller height than the former, in order to turn the body over the edge. It is manifest to every eye that a much less elevation of the outer edge will effect this than would be necessary to raise the first centre through the arc G D.

A remarkable illustration of this fact we have in the following experiment, shewing that it holds true even if the body be supported on a circular surface instead of a plane. A flat body resting on a sphere will have its equilibrium stable or tottering according as its centre of gravity is more or less than the semi-diameter or radius of the sphere above the point of contact. If we support a wooden ball firmly in a stand we shall find that a thin volume will not be balanced on it, while a thick one will not only be supported, but will oscillate to and fro when touched, until it returns to its original position. This arises from the fact that the path of the centre of gravity when disturbed depends for the amount of its steepness upon the inverse ratio of the size of the sphere. Thus if the sphere be small it rises little or none, if large it rises more.

It is for those reasons that a waggon loaded high or having its centre of gravity at a considerable elevation is always liable to overset, therefore the heaviest goods are always put in first. A waggon loaded with wood, hay, straw, or the

like would be overset upon a declivity along which one loaded with the same weight of iron, lead, or stone might be transversely moved with safety. If the inequality of the road or any accidental obstacle were to elevate one side of a waggon or other carriage in motion, it will always recover its position, provided that the centre of gravity remain within the vertical line passing through the point of contact of the lower wheel and the ground, and it is obvious that the higher the centre of gravity is placed the sooner it passes the line.

If the velocity of the motion be very great, the wheel might be lifted off the ground with the momentum, and the centre of gravity be thus carried beyond the vertical line by means of an obstacle which would not have overset the waggon if it had been moving slowly. These considerations show us the necessity of regarding the position of the centre of gravity in the construction of carriages. If, for instance, the wheels are increased in size, thus lifting the body of the carriage further from its base it will be much more liable to overset unless the width of the base be increased by increasing the distance between the wheels.

Every one knows that we can stand more steadily on two feet than one; in the former case the line of direction falls between the two feet, in the latter it comes under the sole of that foot on which our body is supported, for which reason we incline our bodies to that side. In order to stand very firmly we enlarge the base by placing our feet wide asunder. Let a person stand sideways close against a wall with his feet together, he will find it impossible to lift the outer foot because its sole forms the base of the body.

The leaning towers at Pisa and Bologna, the former of which is 315 feet high with an inclination of 12¾ feet from the perpendicular, and the latter 134 feet high and inclination 9½ feet, do not fall because the line of direction of the centre of gravity falls within the base. The monument near London Bridge inclines considerably, and also many of the spires of our churches and cathedrals, especially that of Salisbury.

In the actions and postures of animals, particularly of man, many instances occur illustrative of the properties of the centre of gravity. If a man walks or runs, he inclines forward that the centre of gravity may overhang its base, and he must then be constantly advancing his feet to prevent his falling, while he makes his body incline just enough to produce the velocity which he desires. In pulling horizontally at a load he merely causes his body to overhang its base so that its tendency to fall may become a force or power applicable to the work. When a person stands on one foot and leans forward in the attitude in which the statue of Mercury is usually exhibited, the other foot is elevated behind in order to bring back the centre of gravity so as to be vertically over some part of the foot on which he stands. But on account of the convex and irregular form of the foot, the basis afforded by a single one is in reality very narrow; hence, when we attempt to stand on one foot we often find it necessary to use a muscular exertion in order to bring the point of support to that side towards which we are beginning to fall, and when the basis is still more contracted the body never remains at rest, but by a succession of actions of this kind, often too minute to be visible, it is kept in a state of constant vibration, without ever attaining such a position as would give it any degree of positive stability. Thus it is by habit that the art of rope dancers and balancers is attained.

Sometimes, however, the position of balancer is not so difficult to be preserved as it appears, the curvature of the wire in contact with the foot tending materially to support him.

When we rise from a chair, we first bend the body forward so as to bring the centre of gravity over the feet or base, and then we lift the body up.

If we rise too soon, that is before the body is sufficiently advanced, we fall back again. A man standing with his heels close to a perpendicular wall, cannot, without falling forward, bend sufficiently to pick up any object that lies before him on the ground, because the wall prevents him from throwing part of his body backward to counterbalance the head and arms that must project forward. A man little versed in such matters agreed to give ten guineas for permission to try to possess himself thus of a purse of twenty laid before him on the ground, of course he lost his money. When a man walks at a moderate rate the centre of gravity comes alternately over each foot, and thus when two persons walk together they shake each other unless they step together.

In our next lecture we shall commence the consideration of the Laws of Motion, or Dynamics, and if we can succeed in interesting you, we hope to be able to point out how these laws govern the motion of every object, whether it be a grain of sand, a piece of minute mechanism, or a revolving planet.

LIVERPOOL OBSERVATORY.

Rates of Chronometers on Trial for Purchase by Shipowners and Captains in the Mercantile Marine.

To the Editor of the Horological Journal.

Dear Sir,—The improvement of the ordinary chronometer balance has occupied the attention of chronometer makers so much during the past twenty years, that any information which has a tendency to show its defects, and the efficiency of improvements will, I think, be interesting to your readers. It has for a long time past been known that chronometers with the ordinary balance, if compensated for 50° and 80°, will on exposure to 20° or 110° lose much more in either of the latter, than in the former temperatures. The loss in such extremes is generally

so large, that no refined means of testing are required to detect it. For the practical purposes of navigation we are, however, more immediately interested in the efficiency of the balance for those temperatures to which ships are generally exposed at sea. In the accompanying Table of Rates of Chronometers on Trial for the five weeks ending December 7, 1861, the range of temperature, as will be seen, is only about 40°, and in order to show the efficiency of the balance for this small range, I have had recourse to the following method.

1.—No chronometer has been taken for this purpose in which the mean daily rates in 49° and 89° as shown in colums 8 and 10, differ from each other, more than one second.

2.—No chronometer has been taken in which the rates of either the first and last, or the second and fourth weeks of trial in similar temperatures differ from each other more than one second.

Of the sixty-two chronometers tested, there are twenty-two which come within the above-named limits, and the following table shows the excess of gaining rate in the mean, over that in the two extreme temperatures.

Excess of Gaining Rate in 69°, *over the mean of* 49° *and* 89°.

	s.		s.
No. 1	—0·3*	No. 15	1·2*
2	0·8*	20	1·2
3	0·7*	22	1·4
4	1·0*	23	1·4
5	—1·0*	30	1·6*
6	1·0	33	1·5*
7	0·8	36	2·0
8	1·0	37	2·0*
9	1·0	38	2·1
10	1·1	43	1·7
11	1·2*	49	2·4*

The eleven marked * have balances constructed with the view of removing the tendency to gain in the middle temperature. From this trial, there appears to be but little advantage gained by the improved, over the ordinary balance in a range of 40°. The law of variation is reversed in two cases, but the uncertainty appears greater in the new, than in the old construction. It is very remarkable that the two extremes, Nos. 5 and 49, have the same description of balance, and bear the name of the same maker.

A few years ago I tested some chronometers, in which the balances were opened at two points 90° from the end of the arm, and four weights used instead of two, and the tendency to lose at the two extremes was certainly much less than in some balances opened in the ordinary way which I tried with them.

In the preceding Table, the order of arrangement is that of greatest difference of daily rate between any two of the five weeks, but the quality of each chronometer may be judged of still further, by an examination of the accuracy with which it returns to the same rate in similar temperatures. A large number will be found to be almost perfect in this respect, and this shows how important it is to attend to the temperature, as a general rule, in giving the rates of chronometers. Your's very truly,

JOHN HARTNUP.

NOTES TO THE TABLE.

Columns 1 and 2 contain numbers by which the Chronometers may be identified.

Columns 3 to 7 show the mean daily rate for each of the five weeks, *gaining* when no sign is used, and *losing* when the — sign is used; the range of temperature is given at the bottom of each column.

Column 8 is the mean of columns 3 and 7, and column 9 the mean of 4 and 6.

Column 10 shows the rate in the highest temperature. The object of this arrangement is to separate, as far as possible, the irregularity of performance due to change of temperature from that arising from other causes.

Column 11 shows the greatest change of rate between any two weeks from all causes of irregularity combined; and column 12 that portion which is due to change of temperature.

Column 13 shows the mean of the five extreme differences between any two days of each week; by the numbers in this column the steadiness of daily rate may be seen.

GREAT EXHIBITION, 1862.

To the Editor of the Horological Journal.

Sir,—For the information of the Exhibitors in Class 15, I beg to state that the Committee have entered into a contract for the whole of the counters.

These are to be strongly made, and of an uniform height of 3 feet from the floor.

Exhibitors will be charged at a rate of One shilling per foot superficial, and each will be at liberty to cut away any portions of the space he occupies in order to suit the requirements of his particular articles. The supports will also be left unfixed so as not to interfere with the convenience of the several exhibitors.

The Committee have also ordered the erection of wall space subject to the control of the Superintendent, Mr. Leighton, for which a *pro ratâ* charge will be made.

The contractors have engaged to complete the whole on or before the 29th instant.

Your's respectfully,

JOHN BENNETT,

March 20th. *Chairman of Exhibitors' Committee.*

EQUATION OF TIME TABLE

For April, 1862.

Day of the Week.	Day of Month	At Apparent Noon. — Equation of Time to be *added* to Apparent Time.	Difference for One Hour.	At Mean Noon. — Equation of Time to be *subtracted* from Mean Time
		m. s.	s.	m. s.
Tues..	1	3 58·00	0·753	3 58·05
Wed..	2	3 39·94	0·748	3 39·98
Thurs.	3	3 21·99	0·742	3 22·03
Frid..	4	3 4·18	0·736	3 4·21
Sat...	5	2 46·51	0·729	2 46·54
Sun...	6	2 29·01	0·721	2 29·04
Mon..	7	2 11·70	0·713	2 11·72
Tues..	8	1 54·59	0·704	1 54·62
Wed..	9	1 37·70	0·694	1 37·72
Thurs.	10	1 21·05	0·683	1 21·07
Fri...	11	1 4·65	0·672	1 4·66
Sat...	12	0 48·53	0·659	0 48·53
Sun...	13	0 32·70	0·646	0 32·70
Mon..	14	0 17·20	0·632	0 17·20
Tues..	15	0 2·04	0·617	0 2·04
		Subtracted from		*Added to*
Wed..	16	0 12·77	0·601	0 12·77
Thurs.	17	0 27·21	0·585	0 27·21
Frid..	18	0 41·24	0·568	0 41·25
Sat...	19	0 54·86	0·550	0 54·87
Sun...	20	1 8·06	0·532	1 8·08
Mon..	21	1 20·82	0·513	1 20·83
Tues..	22	1 33·12	0·493	1 33·14
Wed..	23	1 44·96	0·473	1 44·97
Thurs.	24	1 56·31	0·453	1 56·33
Fri...	25	2 7·17	0·432	2 7·19
Sat....	26	2 17·54	0·411	2 17·56
Sun...	27	2 27·40	0·390	2 27·42
Mon..	28	2 36·75	0·368	2 36·77
Tues..	29	2 45·58	0·346	2 45·60
Wed..	30	2 53·89	0·324	2 53·90

TO CORRESPONDENTS, &c.

N.B.—All Advertisements to be inserted in the Journal must be forwarded to W. Hislop, Honorary Secretary, at the Office 35, Northampton Square, E.C. before the 23d of the Month.

All Communications for this Journal should be addressed to the Editor, *at the Office*, 35, Northampton Square, Clerkenwell.

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Moss. Newrath, 65, Cheapside.

THE BRITISH HOROLOGICAL INSTITUTE.

THE ANNUAL DINNER.

(*Continued from page* 91.)

Mr. E. D. JOHNSON.—My Lord Mayor and Gentlemen, I beg you to believe that I am exceedingly sincere in returning thanks for my share of the honour of this toast. This is not the first occasion upon which I have had the privilege of responding to the health of the officers of the British Horological Institute. I have heard a gentleman of considerable power of thought and of no mean eloquence assert that "it was embarrassing to reply repeatedly to the same toast." I could readily understand such embarrassment if the interest in the subject matter of the toast were limited, but such is not the case with me. My interest in the British Horological Institute is unbounded; it grows with its growth, and strengthens with its strength. Year by year the Institute affords me additional proof of its usefulness. Year by year I see sufficient cause to believe that it represents a former social want supplied. A scientific omission obliterated. Year by year I see it patronized by men whose position in their respective sciences would alone shed lustre on an institution which had less claims on the suffrages of society than the British Horological Institute. Year by year I see it extend its usefulness, and absorb within its numbers men whom I believe should be credited instead of blamed for their absence, inasmuch as that absence represents the careful abstaining of Englishmen before they touch what at first sight appear to be new-fangled ideas. I say that instead of blaming them we should praise them for their caution; because, in a good cause, having once obtained their support, coming, as it always will do, from matured deliberation, we run no risk of afterwards losing them through caprice. These anniversaries are times when it may be permitted to a speaker to indulge in a little retrospect. I claim that privilege to-night, because in all that has appeared in the past there are subjects of congratulation. During the past year we have had some, although not a very large, increase of numbers. That smallness of increase should not be wondered at considering the present depression of the horological trades. But although we do not depend upon the munificience of the few, but rather upon the mites of the many, we do not find that those mites are falling off. I think that all the experiences of the past year are subjects of congratulation. We are now recognized in high places, and in some places where we doubted the sincerity of the recognition, we have had practical proof that the former standing aloof was not for the purpose of fobbing off an application, but was the result of a philosophical doubt of the soundness of our position. During the past year the Institute has achieved what I believe no individual influence could have effected in Clerkenwell, namely, the bringing about of the great result that we are now in constant receipt of electrical signals for determining time, sent under the guarantee of the Astronomer Royal daily. (Cheers.) It was supposed by many that the acquiescence of the Lords of the Admiralty in our petition to them for any specimens they might possess of horological curiosity was merely to get rid of the petition by accepting its prayer, when it was known that they had nothing to give. It is true they did at first give but one single specimen, but we did not despair, although outsiders did. We have had cause to congratulate ourselves that we did not allow ourselves to despond. We have since found that their lordships have admitted the claim of the Museum of the British Horological Institute, and have gratuitously sent us for deposit some ancient specimens of the horological art. I think, gentlemen, that I have said quite enough to express my own feelings, and I am sure that every one of the members of the Institute coincides in those opinions with me. On behalf of the officers of the British Horological Institute allow me to tender you my very sincere thanks.

Mr. E. D. JOHNSON again rose, and said—My Lord Mayor and Gentlemen, I have had a special privilege conferred upon me by the Committee. I say "privilege," because I know of no social pleasure greater than that of the opportunity of bearing testimony to the merits of deserving men. You have just responded to a toast with such a degree of cordiality as those most interested in it could desire; but I cannot help comparing the merits of those whom you have praised with the merits of him whose health I am about to propose to you. You have just, with great sincerity, drank tbe health of the President, Vice-Presidents, and Council of the Institute. The presidential chair of an Institution like this derives a considerable portion of its importance and dignity from the character and bearing of the men who fill it. We have a splendid instance of that fact in the person of Mr. Valentine Knight. The vice-presidential chairs on the contrary are supposed to elevate and to honour those who fill them, and therefore being one of those officers I will say no more about that. But the position they all hold in reference to another officer can only be brought to your minds by a simile. Suppose a number of gentlemen agreed to go on a special pic-nic, towards which each should contribute his share of the viands. It will be no strong effort of fancy to suppose them such complete bachelors that they had forgotton to provide a cook to cook their meals. Is it not evident that a cook alone could rescue such a feast from absolute barbarism? That is exactly the position in which the Horological Institute stands with regard to its Honorary Secretary. The President, Vice-President, and Council depend entirely for the efficiency of the Institute upon the efficiency of its cook, the secretary. To him alone is the credit due of bringing into shape and use our crudities. I might

almost say that all which such an association as this can effect is attributable to his exertions. Now, we are particularly happy in having secured the services of such a secretary in the gentleman whose health I am about to ask you to drink, whose broad and comprehensive knowledge of the horological art is equalled only by his industry, and both these qualities are surpassed by his zeal in making them subservient to the interests of this excellent Institute. Gentlemen, I could speak for a long time while touching the merits of our friend, Mr. Hislop; but so great are the services which he renders to us that I fervently hope that he may live many years to benefit it. I trust that he may have health to maintain and inclination to continue the services he is now rendering us.

The toast was drank with great applause.

Mr. HISLOP.—My Lord Mayor and Gentlemen, I beg to thank Mr. Johnson for the very complimentary remarks he has made in proposing the toast, and you for the cordial manner in which you have responded to it. I am not able to apply to myself all that Mr. Johnson has been kind enough to say about me; but I should be guilty of affectation if I did not confess that the duties of your honorary secretary are somewhat onerous, and I think I may claim for myself that I have performed them to the best of my ability. My own feeling with regard to the Institute is, that it is an indispensable means for elevating our art. In giving my time to it I have been merely endeavouring to forward my views, and yours also, of what I believe to be most conducive to the prosperity of watch makers. It would be unfitting in me to attempt to make a long speech upon such an occasion as this. Something was said by Mr. Johnson about the secretary being a cook; at all events, I have not cooked your accounts. I have got a few subscription cards here, which I will read to the meeting.

Mr. Hislop then read the list of donations inserted in our journal for March.

Mr. BENNETT said, that he felt much satisfaction in being entrusted by the Lord Mayor to propose the next toast. He need not remind that assembly of the circumstances that brought the Horological Society into existence. The improvement of our watch and clock manufactures demanded the best efforts of an association of the most eminent mechanicians; they determined to establish periodical discussions bearing on the art and science of horology; they determined too, to take advantage of the willingness of certain able men to deliver a course of lectures; but the most important step they had taken was the establishment of an horological journal. He had the honour then to propose the health of a gentleman to whose ability they were indebted for the superintendence of this valuable record of the Society's proceedings. For his careful selection from the discussions and the lectures, they owed to him a debt of gratitude which with one accord, he felt quite sure they would be most ready to pay. And, therefore, it was with the highest satisfaction it fell to his lot to propose the health of the editor Mr. Gordon, who hitherto, and for a considerable period, had rendered his services gratuitously.

The toast was drank with applause.

Mr. GORDON.—My Lord Mayor, Mr. President, and Gentlemen. It is impossible for me to respond to the toast in the way it deserves. I must only thank Mr. Bennett for the handsome manner in which he proposed the toast, and you, gentlemen, for the manner in which you have received it.

THE LORD MAYOR.—Gentlemen, I have a toast to propose which would really justify under other circumstances something more than a mere brief notice, and that is, "The prosperity of the Watch Manufacturers of England." Now that is a very important matter; for, the question whether watchmaking can be carried on advantageously in England, or whether it is to be given up to foreigners, is a subject that we should hardly like to discuss upon the present occasion, but it is one that cannot altogether be avoided. What are the elements of that question? First of all, the English manufacturer delights in making a very good article. The English character requires that English watches should be good ones. Is it possible to make a very good watch at as small a cost as watches are made in places where, perhaps, cheapness is considered a more important element than quality? I am afraid that our national necessity to make a good article will prevent us competing with these makers who regard only price and not quality. I do not know how that difficulty is to be got over. As an Englishman, I would rather say let us maintain our character for a good article, because, I believe that in watchmaking, as in everything else truth is strong and will prevail, and nothing is of so much importance as truthfulness in a watch. The fact of your being able always to depend upon your watch gives value to it far beyond the saving of a few shillings in the cost. Well, perhaps, for a time cheapness may go against the English manufacturer; but in the long run the truthfulness of the article will prevail; and I therefore hope, whatever may be the result, that at all events we shall not give up our desire and ambition to make a good watch. In proposing the toast I have now the honour of offering to you I wish it to be understood as my opinion, that no prosperity can last long which is not based on honesty and truth. I beg to associate with the toast the name of Mr. Frodsham.

The toast was drank with loud applause.

The LORD MAYOR.—I have now to propose a toast of great importance, and that is in reference to what the watch and clock makers may do at the forthcoming International Exhibition. It is of vast importance to every one who rejoices in the name of an Englishman, that upon that occasion English talent may be fully vindicated. I beg to associate the name of Mr. Bennett with the toast. I know that he has a right feeling about these things, and that he will get up and state for himself, and every one in this room, that he meets the coming event with confidence. I suppose that he will tell you, what will be applauded throughout this room, that he believes that after it is over the Clerkenwell people will have occasion to say to each other, "Well, we got on very well at the Great Exhibition."

Mr. BENNETT in reply to the toast of prosperity to the coming event, said—My Lord Mayor and Gentlemen, it is due to the important branch of manufacture, with the success of which at the approaching exhibiton you have done me the honour

to connect my name, that I should speak of it in terms of confidence and hope. Indeed, to the interest I took in the Great Exhibition of 1851, and to the time I have devoted during the last ten years to render the lesson it afforded conducive to the interests of the watch manufacture, I may attribute the fresh duty I have been called upon to perform as Chairman of the Watch and Clock Department of the Great Exhibition of 1862. The building is indeed a mighty mass. Its external aspect does not strike us in any degree as being so imposing as the Napoleonic structure erected for a similar purpose in the *Champs Elysées;* but within, we shall find a bright light, ample breadth of space, and a magnificent general effect. As watch makers we are bound to consider how far its results will be found beneficial to our particular trade. This is the very question I brought before the Society of Arts in 1851. I regret that the subject was then treated so lightly that Mr. Vulliamy declared the foreign watch to be only a toy from which we had nothing to fear, and there are great men even now who are ready to echo his words. Can this be a right view of the matter when we know that the foreign clocks and watches imported into this country in 1850 amounted in value to £174,000, and that in 1860 the value of those imported had increased to £565,000, independent of an incalculable number brought over by private individuals? Is it not our wisest course to reflect on the serious character of the lesson these exhibitions afford, when we find that our manufacture is decreasing, whilst that of our rivals is increasing most overwhelmingly? I have always protested against the necessity of such a decline and fall, if we will but be alive to the best means of improvement. Is it credible that in the land in which George Graham produced a perfect astronomical clock one hundred and fifty years ago—where Harrison laid down the main principles of the marine chronometer above a century ago—which instrument, within fifty years afterwards, was brought to perfection by Tom Earnshaw, the greatest horologist, perhaps, who ever lived—is it credible, I say, that in such a country we should allow a rapid decline of English watch making to go on? The Astronomer Royal has told me that for all practical purposes the chronometer was beyond the need of further improvement in performance. As to price, I would undertake, within a week, to supply five hundred of the finest chronometers, thoroughly tried at one-third the price which my grandfather charged for the same kind of instrument. If, then, the highest quality is consistent with so large a reduction of price in the chronometer, why is not a similar decrease in the price of the best pocket watch also possible? We know that the price determines the amount of the sale. We live in the days of free trade. This Exhibition will not only be a lesson to us but to the public also. We have sent out a challenge to all the world to come to the World's Fair. There they will judge for themselves of the merits of the various articles exhibited, and cheapness will be as much an element of success with the exhibitor as quality. We must show the improvement we have made in comparison with our rivals. Our failures, as well as our successes, must be manfully looked at, and their causes must be searched out. We cannot blink the fact that the question, "What to make," must be followed by the inquiry, "How to make it?" The right solution of these queries will determine the measure of our success. What that may be will soon be seen. The Lord Mayor has expressed a wish that I may be able to speak with confidence of my expectation of the results of the coming Exhibition. Gentlemen, I hope for the best. I believe that we have made progress during the last ten years. I think that the rising generation of Clerkenwellers are a more thoughtful race than the past. They know that the world of buyers will have their watches flat and beautiful in appearance, as well as trustworthy in execution. The best watch for the least money is the thing required for the market; and if we succeed in producing it we shall not only satisfy the consumer, but at the same time benefit the producer. Master and man will reap the harvest together. Our trade will again flourish, and the result of the forthcoming magnificent Exhibition will be a great moral good, and a vast social blessing to the community.

Mr. John Jones.—My Lord Mayor and Gentlemen. At this late hour it is desirable that we should pass as rapidly as possible through the remaining business of the evening. The toast I have to propose is the health of the Foreign Watchmakers. We meet to-night under the auspices of the British Horological Institute, an association of a most expansive character, which, however humbly it may have commenced is now world-wide in its reputation and in the benefits it confers. The Horological Institute is not exclusively British, but it is the institute of its kind for all men. The foreign manufacturers I confess have somewhat of antagonism to the British; but when they enter the British Horological Institute, that antagonism vanishes. Outside we are engaged in the pursuit of money, and of what money brings, namely fame and distinction; the distinction which the world gives us; but within we are worshippers before the throne of nature's mysteries; there, we all forget the distinctions of society, the distinction between natives and foreigners in the presence of the august majesty of Nature. Gentlemen, we must not say anything against the foreign watchmakers; had it not been for them Clerkenwell would not have been so filled, as it now is with watchmakers; men who were oppressed in foreign nations by arbitrary rule, found an asylum in England, and brought their knowledge and wit with them there. Although they brought their trade with them they got here real advantages which despotism could never have given them. I quite agree with Mr. Frodsham that in their own countries they are not equal to the English watchmakers. My brother tradesmen will admit that foreign watchmakers do pursue very honourably every branch of the horological art. The foreign watchmaker knows that the world is his to inherit, and that he can go where he pleases. Therefore, when I see a foreigner come to this country to pursue his art, I feel that that man is a man of mark, for unless he had been so, he would not thus have left his home unless it be occasionally; it will always be found that they have left their homes for this reason. I welcome them to the Horological Institute as brethren, co-operating

for the general advancement of the art. I recollect reading of a great man who was represented as being very condescending in going into workmen's shops. Gentlemen, in our workshops, the principles of nature which are godlike, are the principles with which we are conversant; and, with these, both the foreign and native workmen are familar.

The toast was drank with applause.

Mr. LUTIGER, in replying to it said, My Lord Mayor and Gentlemen. I feel it to be rather a difficult task to respond to the kind toast which you have just drank of the health of the Foreign Watchmakers. We very humbly thank you for your kind observations which will induce us in future the better to deserve your honourable notice of us. Our watches and clocks have been duly appreciated here, not only our cheapest watches, for the making of which we have a reputation, but also for our more elaborate work. Gentlemen, you will excuse me saying more as I am not well acquainted with your language. I can assure you that I represent the feelings of the foreign watchmakers when I say that we are deeply grateful for the patronage and appreciation of the English horologists.

Mr. S. JACKSON, in proposing the health of the Visitors, coupled with the name of Professor Tennant, said, I feel myself much in the position of counsel who, prepared to advocate a cause, on arriving in court, is called upon suddenly to take up a different brief. Our right honourable Chairman himself has introduced to you in fitting terms the toast of Horology at the Exhibition with which the Committee had done me the honour to entrust me. So the premeditated eloquence I was charged with, you will please to take for granted. At this late hour, I wish briefly, to record, on behalf of the Institute, the members' sense of the gracious presence of gentlemen distinguished in kindred science, as well as that of others who have honoured our social gathering to night, and to express the hope that our association may continue to enjoy their esteem and society.

Before sitting down allow me to advert by a word or two to the coming Exhibition. The important principles of representative election carried out by the Royal Commissioners in the appointment of committees, jurors, &c., have assured as far as possible that which is dear to Englishmen, Fair play. It will be a competitive trial, and must be so regarded. Let us hope all engaged will do their best to maintain the credit of British Horology, and that we may on the day of trial obtain a verdict of success.

The toast was received with applause.

PROFESSOR TENNANT:—My Lord Mayor and Gentlemen. I will only express my thanks to you for permitting me as a stranger to come amongst you this evening. On a previous occasion I had the good fortune to be present at one of these interesting gatherings of the Institute, and I feel happy at being a guest on the present occasion.

The Lord Mayor proposed "The Press," coupled with the health of Mr. Farmer.

Mr. FARMER returned thanks, and begged leave to propose as a toast prosperity to the locality in which the Institute was situated—Clerkenwell, connected as it was with the names of the Lord Mayor, and of the senior churchwarden of the district, Mr. Wright, who was formerly an apprentice of the Right Honourable the Lord Mayor, then in the chair.

The toast was drank with applause, and was acknowledged in a neat and able speech by Mr. Churchwarden Wright.

The LORD MAYOR having proposed "The Ladies," at the same time making special mention of the vocal services rendered during the evening by Mrs. Cooper and Miss Howard. The toast was duly honoured, and the proceedings terminated.

MECHANICS.

Fourth Lecture delivered to the BRITISH HOROLOGICAL INSTITUTE.

BY W. HISLOP, ESQ., F.R.A.S., HON. SEC.

December 31st, 1861.

(*Continued from page* 95.)

Dynamics is that branch of mechanics by which we investigate and compute the action of solid bodies upon each other when the result of that action is motion. Motion is a simple idea. One of the ancient philosophers when asked to define it, walked across the room, and said "You see it, but what it is I cannot tell you." In conformity however with established usage, I may define it to be that state in which a body is when passing from one point of space to another.

If there be anything which does not need proof of existence it might be supposed to be simple motion, a thing never absent from one moment of the waking perceptions, nor even from our dreams. Its existence however has been denied or is reported to have been denied by various of the Greek Sophists. According to Sextus Empiricus, Diodorus surnamed Cronus, a Carian disproved the existence of motion as follows:—

"If matter moves it is either in the place in which it is or the place in which it is not; but it cannot move in the place in which it is, and certainly cannot in the place in which it is not;—consequently it cannot move at all"—To which the first named author replies that by the same rule, men never die, for if a man die, it must either be at the time when he is alive, or at a time when he is not alive. The argument may however be

demolished by the consideration that all material phenomena happen either in the place in which the matter is, or in that in which it is not, except only the change from that place in which the is, and will not be, to that in which it is not but will be. This Syllogism of Diodorus may be useful to remind us that motion implies both spaces and times, since the sophism excludes the latter from consideration.

Motion is the result of force, to speak generally. It is natural to endeavour to imagine in what immediate manner any force acts so as to produce motion, for instance, by what means the earth causes a stone to gravitate towards it. In some cases, indeed, we are disposed to think we understand better the nature of the action of a force, as when a body in motion strikes another, we conceive that the impenetrability of matter is a sufficient cause for the commencement of motion, since the first body cannot continue its course without displacing the second, and it has been supposed that if we could discover any similar impulse, that might be the cause of gravitation, we should have a perfect idea of its operation. But the fact is, that even in the cases of apparent impulse the bodies impelling each other are not actually in contact, and if any analogy between gravitation and impulse be ever established, it will not be by referring them both to the impenetrability of matter, but to the intervention of some common agent perhaps imponderable. It was observed by Newton that a considerable force was necessary to bring two pieces of glass into a degree of contact which still was not quite perfect, and Professor Robison has estimated this force at a thousand pounds for every square inch. The extremely minute interval has been estimated by observation on the colours of the thin plate of air, included between the glasses, and when an image of these colours is exhibited by means of the solar or gas microscope, it is very easily shown that the glasses are separated from each other by the operation of this repulsive force, for as soon as the pressure of the screws which confine them is diminished, the rings of colours dependent on their distance are seen to contract their dimensions accordingly.

Hence it is obvious that whenever two pieces of glass strike each other without exerting a pressure equal to a thousand pounds on the square inch, they may affect each other's motion without actually coming into contact. Some persons might perhaps attribute this repulsion to the elasticity of particles of air adhering to the glass,—but the experiment succeeds equally well in the vacuum of the air pump.

We must therefore be content to acknowledge our ignorance of the ultimate nature of forces of every kind and we have only to examine their effects.

Motion reigns throughout nature and it is probable that absolute rest is nowhere to be found in the universe. Motion may be either apparent or relative. Thus to a person on board a moving vessel, objects on shore appear to be in motion in a direction contrary to that in which the ship is moving. A similar appearance is presented by the trees on a road side, to a person travelling in a carriage. Again, the sun appears to revolve around the earth, while in fact, the earth revolves around the sun and on its own axis. To illustrate this still further, if a ship be in motion at the rate of two miles an hour, and a person walk from the head towards the stern at the rate of two miles, we shall have a complicated case of relative motion. The individual in question will be in motion with regard to the ship, but at rest with regard to the earth. The ship will be in motion with regard to the earth, while the latter will itself be in motion with all it contains in regard both to the sun and the heavenly bodies, in a proportion varying according to the respective states of those bodies. Even the sun itself revolves on its axis, and the solar system is in motion with regard to the other heavenly bodies, while the whole astral system may be in motion for aught we know, with respect to some point of absolute rest, unknown to and far beyond the ken of man.

In all the various changes, which the raw productions of nature must undergo in order to adapt them to supply the wants of civilized life, motion is the principal agent. The wool, which is taken from the sheep, requires to be put into a rotatory motion in order to form it into threads; these threads have again to be submitted to a variety of other motions, in order to produce that arrangement which gives them the form of cloth, and this cloth must pass through a variety of processes, in which motion is the principal agent, before it is prepared for use. In order to obtain these motions, we avail ourselves of the forces, which we find actually existing in nature, such as that afforded by streams of water, the wind, the strength of animals, and various others. All these forces however have to be modified by machinery, constructed after the laws of mechanics. It may happen, that the force we have at command is of very variable intensity, such as the wind, while the force which we require should be of a perfectly uniform character. We are therefore compelled to contrive some means by which this force may be so modified in its transmission, as to be rendered uniform, or very nearly so. Again, the natural force may constantly act in one direction; as for example, a running stream, while it may be required that the motion at the working point should be alternate or reciprocating, such as that which is necessary to work the piston of a common pump. In all these cases, apparatus must be interposed between the natural agent and the working point, which shall be capable of converting the one species of motion into the other.

It will be seen from these remarks, that motion may be either Uniform or Variable. It is uniform when it moves always in the same manner, or when it passes over equal spaces in equal intervals of time. Strictly speaking, however, there is no perfectly uniform motion existing in the universe. Still, when equal spaces are passed over in very nearly equal times, the motion is called uniform, and the amount of motion or velocity is estimated by the space which any body passes over in any assumed unit of time, as a minute or a second. As time, space, velocity, &c., are quantities incomparable with each other, it has been usual to distinguish the relation between them by the expression, "is as." Thus, it is said,

that the time *is as* the space divided by the velocity, the space *is as* the time into the velocity &c.

It is not only necessary in order that the doctrines of mechanics may be brought within the bounds of mathematical and experimental investigation, that the quantities it proposes for discussion, should be measurable either in themselves or in their effects; but it is also necessary that some general principles should be exhibited, the truth of which should be incontrovertible, and to which we may at all times appeal in the course of our researches. Such general principles were first distinctly proposed by Sir Isaac Newton, in his "Principia." They have since his time been received as mechanical axioms, or as they are commonly called "The Laws of Motion."

They are as represented in the diagram.

1.—*Every body continues in its state of rest or motion, until a change be effected by the agency of some force.*

2.—*Any change effected in the quiescence or motion of a body is in the direction of the force impressed, and is proportional to it in quantity.*

3.—*Re-action is equal, and contrary to action.*

We proceed to examine the first law.

The cause of the tendency alluded to in this law is called "Inertia." It may therefore be called the Law of Inertia.

A body does not change its state either of rest or motion unless in consequence of some external cause. This property will cause a body once in motion, to continue in motion for ever, unless some extraneous force acts upon and retards it. So with a body at rest; it will never start into motion of itself unless some force is brought to act upon it. Each of these forces whether accelerating or retarding, meets with a certain resistance, and overcomes that resistance in proportion to its own energy and the mass, velocity, &c., of the body acted on. A stone thrown from the hand would continue in motion for ever, did it not meet with resistance from the surrounding medium, while it is evident that it would not start of itself. Of the former case we may take as a practical exemplification, the revolution of the planets with their attendant satellites and atmospheres around their own centres and around the sun. By some tremendous and magnificent power wielded by an infinite intelligence, they have been at some remote period of time launched into motion, and they continue to revolve and will continue to eternity, unless disturbed or stopped by the same mighty hand that first impelled them!

To illustrate this still further. A ball which is rolled along the ground, soon ceases to move, but rolls much further on ice, simply because less obstruction is offered to its progress by the smooth surface of the ice, than by the greater roughness of the ground; and if we continue thus to remove the impediments to the motion of the ball, it will move farther and farther as the resistance lessens.

As before mentioned, the resistance of the air, if we had no other obstacle, is sufficient to retard and eventually to destroy motion. When this cause is greatly removed it is remarkable to observe the effect of an impulse. A common top, for instance, set in motion in the exhausted receiver of an air pump will continue to spin for hours, and a pendulum set in motion under the same circumstances, will swing for a whole day without the aid of clock work.

For the same reasons a body is incapable of increasing or diminishing any motion which may have been imparted to it. Thus if a body be moving in any direction at the rate of ten miles an hour, it cannot by any energy of its own, change that rate to nine or eleven miles an hour. The same power which would cause a body moving at the rate of ten miles an hour, to move at the rate of eleven miles an hour would also cause the same body at rest to commence moving at the rate of one mile an hour, and the same power which would cause the same body moving at the rate of ten miles an hour to move at the rate of nine miles an hour, would cause the body moving at the rate of one mile an hour to remain quiescent. It therefore appears that to increase or diminish the motion of a body is an effect of the same kind as to change the state of rest into that of motion or vicê-versa.

(*To be Continued.*)

BERTHOUD'S DESCRIPTION OF HIS MARINE TIME-KEEPER, No. 8.

TRANSLATED FROM HIS "TRAITE DES HOROLOGES MARINES."

(*Continued from page 73.*)

CHAPTER XII.

Of the Escapement with free vibration; and of the application which I made of this Escapement to the Marine Chronometers Nos. 3, 4, *and* 9.

The Marine Chronometers Nos. 6 and 8 had shown sufficient precision in their rates during the trials which were made with them at sea, to convince me that such kind of machines might be useful to navigation, whether to rectify the charts or to serve for

conducting a ship; so that if it were not possible yet to perfect these machines, they might still be of great assistance. Now we have shown, in treating of Nos. 6 and 8, how possible it is to construct marine chronometers superior to these, and we formed this opinion upon sure principles, verified by exact experiments: and it is by their aid that we have succeeded in finding out the causes of their variations. We have already indicated, by a train of these researches, the means of still perfecting them: and among these must be reckoned the escapement and the spiral, since these parts are of the greatest consequence. We refer for what concerns the spiral to the latter part of Chapter III, 3rd part, and we intend, in the present chapter, to treat solely of the escapement with free vibrations, and of the application which has been made of it to three of the chronometers.

The essential conditions that theory demands from the most perfect escapement, are 1st, that the motive force should be transmitted to the escapement without loss, that is to say, that the escapement wheel should communicate to the balance the force which it receives from the mainspring with the least possible amount of friction, 2nd, that after the wheel has given the impulse to the balance, the latter proceeds to finish its vibration freely and uncontrolled; 3rd, that the action of the escapement, shall not in any way whatever change the nature of the vibrations of the balance; that is to say, that if the vibrations of the balance are isochronous, they must equally be so, after the application of the escapement to the chronometer; 4th, that the escapement should require no oil, so that the friction which it experiences shall be the least possible, and that consequently, the variations in the amount of friction which may supervene, will never be capable of affecting the rate of the chronometer or of altering the isochronism of its vibrations. Such are the properties which I was desirous of obtaining in an escapement when I was treating on the theory of marine chronometers; and these properties are happily found united in the escapement with free vibrations I am now about to describe, and of which the first application was made to the chronometer Nos. 9 and 3. I will also relate, at the end of the description of it, the experiments which I have made since its application to chronometers.

Description of the Escapement with free vibrations such as I composed it, in 1754.

In the escapements at rest such as are now known and employed immediately after a tooth of the wheel has given its impulse to the balance, the same tooth proceeds to rest upon the cylindrical portion borne by the axis of the balance, so that this tooth presses against the cylinder or circular portion of that axis during the time the balance is finishing its vibration. Now, as this portion of the cylinder is concentric to the axis of the balance, it necessarily follows, that during the time the balance is completing its vibration, and that the action of the escapement wheel is thus suspended by the cylinder or portion of circle borne by its axis, the escapement wheel remains perfectly motionless, that is to say, it neither advances nor recedes; it is for this reason, therefore, that this kind of escapement is called a dead-beat escapement. But as we have already said, this escapement, notwithstanding its apparent advantages, is subject to a certain amount of friction and the variations which are consequent thereon; it therefore requires oil and thereby engenders an amount of injurious resistance. Such were the difficulties which I have observed in the ordinary dead-beat escapements, and which caused me to occupy myself in researches for some means of remedying the defects to which it is subject. I combined, for this effect, the escapement in such a manner, that as soon as the wheel had given its impulse, the balance might complete its vibration freely, and, that during this time the effort of the wheel should not be suspended as in the dead-beat escapement by the balance itself, but by a detent which the balance itself disengages in an inappreciable space of time, so that the balance experiences no other species of resistance or friction than that of disengaging the detent which was suspending the action of the wheel; while the balance itself was vibrating freely; such was my first idea of an *Escapement with free vibrations.*

In this escapement the balance makes two vibrations whilst only one tooth of the wheel escapes in one single space of time, that is to say that the balance goes and returns and as it returns at the second vibration, the wheel in the act of escaping, restores to the regulator in one vibration, the force it has lost in two; thus, during one entire vibration and the greater part of the second* the force of the wheel is suspended by a detent, so that the balance during this time, is vibrating freely. I have given a notion of this escapement after the model I made of it in 1754: the following description however will serve still better to give a correct idea of it.

* The wheel acts upon the balance only during the time of giving the impulse, which is only about 40 degrees of arc.

Plate XIX. Fig. 4.

A B is a portion of the circle of the escapement. This circle should be fixed upon the axis of the balance which, let us suppose, makes each vibration in a second, and it ought to be placed outside the rollers: it is to the centre of this circle that the clip of the suspension spring should be attached; *a* is the roller, placed upon the circle of the escapement: this roller has one of its pivots which turns in the circle itself and the other in the bridge *b*; it is upon this roller that the *impulse lever c d*, moveable at *d* upon two pivots, is to act: the pallet or little arm *d e* of this lever is acted on by the escapement wheel C; this wheel is to be fixed upon the axis which carries the second's hand; and as it has 15 teeth it revolves once in a minute,* since as we have already said, the balance makes two vibrations while only one tooth of the wheel escapes.

When the tooth *f* of the wheel has arrived at the extremity of the pallet and has communicated the impulse to the escapement, the succeeding tooth *g*, goes forward to rest upon the arm *h* of the anchor *h i*, moveable on *k*; so that the force of the wheel remains suspended whilst the circle A B turns from *a* to B, and also as it returns from B to *a*; but, on its return, when the point *l* has arrived close towards the fork *m*, the pin *l* placed in this point *l* of the circle, removes the arm *m* of the fork, and allows the wheel to escape the exact quantity only necessary to disengage the tooth *g* of the wheel over the arm *h* of the anchor. The tooth *n* then proceeds to rest upon the arm *i* of the anchor, when the wheel becomes stopped again, and, as well as the anchor remains motionless during the time the circle continues to turn from *a* towards A. At length, when the circle returns from A towards *a*, the pin *l*, which it carries, meets the second arm *o*, so that the tooth of the wheel which was resting upon the arm *i* of the anchor, escapes; and it is at this moment that the wheel acts upon the pallet *e*, and that the arm *c* gives an impulse to the roller, and consequently to the circle of the balance which carries it. When the tooth of the wheel has arrived at the extremity of the pallet it is requisite that this pallet should be kept up to its work, and it is for this purpose that the spring *q* is destined, and acts upon the spur *r* borne by the axis of the impulse lever: this lever then assumes the position represented by the dotted line *d s*: in which place it is retained by a pin which regulates its course.

The pressure of the wheel upon the arm of the anchor might probably be sufficient to retain the anchor whilst the balance is vibrating freely; but in order to assure myself more fully of this effect which is of great importance, I added a third arm *t k* to this anchor: this arm is angular like the tooth of the star-wheel of a repeater, and has the same functions; for, by means of the spring *u x*, the angle *x* of this spring, allows it to act alternately on the one side or the other of the star-wheel-tooth and retains the anchor so securely that no agitation is able to withdraw the wheel from its hold. Thus this anchor cannot quit its hold unless the pin in the escapement circle should act on one or the other arm of the fork, in the manner that has been already explained. The pins 1 and 2 serve to restrict the path of the anchor: this path must be the exact

* This is evidently an error in the orginal description, as a wheel with 15 teeth revolving in a minute demands two seconds for each vibration.—E.D.

quantity only to insure the arm of the anchor being ready in position between the teeth of the wheel to catch the succeeding tooth after one has escaped. The bridge D receives the axis of the lever and impulse pallet; and the bridge E, that of the anchor.

The above is a general description of the dead beat escapement, such as I composed it in the first instance; there is, however, some difference between that and the model which I subsequently made of it; for instead of the bent lever I mentioned, I employed the fork *m o*, the effect of which appeared to me more simple; besides which, the bent lever placed at the extremity of this lever *m*, rendered it too heavy, &c.

But I have already said that the defect which I found in this escapement, was, that of not presenting in its effects the requisite amount of certainty; for, notwithstanding the safety spring which retains the anchor, it might happen (although in truth with difficulty) that the anchor by a violent shock might allow the wheel to escape: moreover I found that the spring requisite to insure the bringing back the impulse lever must be a drag upon the wheel-work, which, however, is not of much consequence: but that which most displeased me in this escapement, is, the resistance that the fork itself opposes to the balance, and this resistance is so much the greater as the fork is long and heavy, and the same may be said of the two arms of the anchor. The safety spring or jumper must also be so much greater and the resistance to the balance proportionally greater likewise; in fact this escapement appeared to me too complicated. It was for the above reasons that I did not apply it to my first marine chronometers, and it was not until after I had convinced myself by a set of trustworthy experiments, how much the ordinary escapements at rest may be the cause of variations, that I set about my endeavours to perfect it; since, as we have already said, it was particularly in the change in the state of the oil applied to the escapement, that the Chronometers No. 6 and 8 have been subject to such sensible variations: it was the difficulties that I experienced in this part of my marine chronometers that obliged me to seek the means of perfecting the escapement; and I am happy to say I succeeded in my endeavours in the manner I am now about to explain.

I entirely suppressed the impulse lever,* and caused the escapement wheel to act directly upon the escapement circle, but with such an arrangement, and so simply, that the effects were more certain, that is to say, that the wheel cannot turn separately from the escapement circle; and this disposition of the parts is at the same time more perfect. All these advantages I obtained by placing the wheel and the circle in the same plane, in such a manner that the curve of the circle should fill the vacant space of one tooth, which prevents the wheel from turning, and it can only do so when the notch of the circle presents itself; it is at the moment of giving impulse that the wheel is able to do so. I have also simplified the escapement by the suppression of the anchor, and the employment of a click only, or species of detent, which a pin of the circle raises to disengage the wheel at every second vibration of the balance; and such being the effect, this mechanism is not longer (properly speaking), to be called an escapement, according to the sense that is usually attached to it; for the wheel only acts in one single time for two vibrations. That is at the instant that it gives the impulse, after which it remains motionless, until it gives a new impulse &c.

Description of the Escapement with free Vibrations, applied to the Marine Chronometer No. 4.

Fig. 5, plate XIX., represents the escapement with free vibrations, such as it was

Plate XIX. Fig. 5.

applied, to the Marine Chronometer No. 4, and exactly with the same dimensions. I rendered the balance of this chronometer larger and heavier, than it was at first, in order to make it beat half-seconds, whereas the vibrations of this balance were to have been quarter seconds; the escapement wheel has 10 teeth; now, as the vibrations are

* It is true, that by doing away with the lever, I augmented the wheelwork by a wheel and a pinion; so that considering simplicity only, nothing is gained; nevertheless, by the new disposition of the parts the effects are more certain, and that is a considerable advantage.

half-seconds, and that the balance makes two while the wheel advances one tooth, it follows that this wheel must make six turns per minute. The escapement circle has the same diameter as the escapement wheel; now, this wheel having 10 teeth, we perceive that the arc of escapement must be the tenth part of the circumference of the circle, that is to say, 36 degrees, or equal to the space between two teeth.

The escapement wheel A, is arrested by the click B, during the whole time the balance is going and returning, that is to say, while it makes two vibrations; this click is kept to its work by the spring *a*, and moves upon two pivots between the plate and the bridge *b*.

C is a circle or wheel which is attached by two screws upon a plate forcibly thrust upon the balance axis, and jutting out from without the friction rollers: this circle carries a pin *c*, that is to act upon the arm *f* of the click, in such a manner that when the circle turns from *c* to *e* (that is to say, from the side in which the escapement wheel turns) this pin raises the arm *f* of the click, and disengages the wheel; and at this moment the pallet *g*, placed in the thickness of the circle C and at the same height as the wheel, then presents itself: thus the tooth *i* of the wheel enters into the notch made by the side of the pallet and produces the impulse. During this time, the pin *e* quits the arm *f* of the detent; and the click, by the pressure of its spring puts itself in position to stop the wheel again as soon as it has given the impulse to the escapement circle. The tooth *i*, having quitted the pallet, finds itself disengaged from the notch; but at that time the escapement circle finds itself engaged between two teeth of the wheel, as is to be seen between *e* and *i*: now the wheel cannot have the liberty of turning again, but when the click is subsequently disengaged, and another tooth of the wheel enters into the notch of the escapement circle, to communicate a fresh impulse. By this arrangement, the effects of the escapement are rendered perfectly certain.

When the balance is returning, that is, in the direction from *e* to C, the pin which it carries just strikes the hinder part of the arm *f* of the click; now, the end of this arm is fixed to an inclined plane on this side, and it is rendered very flexible, in order that the pin, instead of abutting against it, causes it to yield in rising; the pin then slides upon the inclined plane without offering any other obstacle to the vibration of the balance than a small and very short resistance, this arm having become very feeble.

The escapement wheel, as we have just said, should be placed at the same height as the circle of the balance; so that the circle by its curvature, shall effectually retain the wheel, and without touching the teeth, while the balance is freely finishing its vibration. But if it should happen that by an accident or sudden shock the click should be disengaged and the wheel allowed to turn before the instant the pin should detach it; such an effect (which I believe cannot happen) would cause no derangement; for the escapement wheel could not escape nor mark more time than the balance ought to measure: the utmost therefore that could result from it would be, that a tooth of the wheel instead of dropping upon, and being retained by the detent, would rest upon the escapement circle. But still, this supposed accident cannot take place; and if it should happen, that would cause no derangement in the *rate* of the chronometer.

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

(*Continued from page* 60.)

1847, February 19,—No. 11,584.

BAIN, ALEXANDER.—1. The patentee remarks that, in former Letters Patent taken out by him, one mode of giving motion to clocks by means of pendulums acted upon by currents of electricity was by causing the pendulum to carry a coil of wire, which moved with the pendulum, while the magnets were held stationary, the currents of electricity passing through the coils being made and broken by means of a sliding bar or "break" acted upon by the pendulum. By the present arrangement the magnets are placed in a frame carried by and moving with the pendulum, while the coils of wire are wound round stationary frames.

2. In constructing the "breaks" or sliding bars, it has been usual to have gold points projecting from the sliding bar, these points being caused to travel to and fro over a smooth surface of agate, in which, and level with the surface of which, are pieces of gold in connection with the different wires. In this invention the gold ends of the wires are made to project in the form of points above the surface of non-conducting substance through which they pass. The point of a wire from one of the poles of a battery is constantly in contact with a groove at one end of the sliding bar. The other end of the bar is similarly formed, but, the points of wires terminating in the other pole of the battery being of a different height, in one position this end of the bar only rests on the point of the wire which is nearest to the centre of the sliding bar. The extreme part of this end of the sliding bar is on a

the minimum was 29·209 at midnight of the 28th; the range was therefore, at least 0·983 inches.

On the 5th, from 4 p.m. to past midnight, a strong gale blew from SW and S.

On the 6th in the evening there was a moderate gale from SW.

On the 7th also in the evening a strong gale prevailed for some hours from WSW.

On the 8th the wind veered to S and SE, moderate with fine weather, but as has been often observed when the wind backs to this quarter after a SW gale, it was but the prelude to another. About 5 p.m. the wind veered to SSE and soon after to S, increasing in force, until at 8 p.m., the gale fairly set in from SSW, and continued all night and the following day until about 6 p.m., when it began to abate. At 7½ p.m. of the 8th lightning was seen. During this stormy period there were frequent violent squalls, and several showers, but the amount of rain which fell did not exceed 0·08 of an inch.

Between the 16th and 20th the wind veered from E through S, W, and N, to E.

During the 24 hours ending at 9 a.m. 21st, there was continuous rain and snow, which, melted in the gage, measured nearly an inch, or the twenty-fourth part of the annual rain-fall.

On 22nd at noon, a sudden shift in the wind took place from N to SE, light.

Between the 24th and 31st the wind veered from SW through S, E, N, and W, to SW.

On the 3rd, 28th, and 29th, the barometer was very low and almost steady, and on each day the wind was between N and NW, light, nor was there any rain to speak of; a very unusual occurrence?

Rain fell on 22 days, during about 130 hours, including 12 hours snow, and the large amount of 3·4 inches was collected.

If the 9 a.m. wind observations are referred to the N, E, S, and W points, they will be found to be equally divided. R. S.

ERRATUM.

To the Editor of the Horological Journal.

SIR,—Allow me to correct an error in the last number of your Journal, wherein Mr. Ganney is reported to have made me represent Mr. Cole as expressing himself unfavourable to the adoption of the Going Barrel for a cheap watch. What I said, was, that Mr. Cole did not recommend the re-adoption of the Horizontal Escapement for this purpose. I am, &c.,

S. J.

March 22, 1862. 66, Red Lion Street.

EQUATION OF TIME TABLE

FOR MAY, 1862.

Day of the Week.	Day of Month.	At Apparent Noon. Equation of Time to be subtracted from Apparent Time.	Difference for One Hour.	At Mean Noon. Equation of Time to be added to Mean Time.
		m. s.	s.	m. s.
Thurs.	1	3 1·67	0·302	3 1·68
Frid..	2	3 8·92	0·280	3 8·93
Sat...	3	3 15·64	0·258	3 15·65
Sun...	4	3 21·82	0·235	3 21·83
Mon..	5	3 27·47	0·213	3 27·48
Tues..	6	3 32·57	0·190	3 32·58
Wed..	7	3 37·13	0·167	3 37·15
Thurs.	8	3 41·14	0·144	3 41·15
Fri...	9	3 44·60	0·121	3 44·61
Sat...	10	3 47·49	0·097	3 47·49
Sun...	11	3 49·82	0·074	3 49·82
Mon..	12	3 51·59	0·050	3 51·59
Tues..	13	3 52·79	0·026	3 52·78
Wed..	14	3 53·42	0·002	3 53·42
Thurs.	15	3 53·47	0·022	3 53·46
Frid..	16	3 52·94	0·046	3 52·94
Sat...	17	3 51·84	0·070	3 51·84
Sun...	18	3 50·16	0·094	3 50·16
Mon..	19	3 47·91	0·118	3 47·90
Tues..	20	3 45·09	0·141	3 45·08
Wed..	21	3 41·70	0·164	3 41·69
Thurs.	22	3 37·76	0·187	3 37·75
Fri...	23	3 33·26	0·210	3 33·25
Sat....	24	3 28·22	0·232	3 28·21
Sun...	25	3 22·66	0·253	3 22·65
Mon..	26	3 16·59	0·274	3 16·57
Tues..	27	3 10·02	0·294	3 9·99
Wed..	28	3 2·96	0·313	3 2·94
Thurs.	29	2 55·44	0·332	2 55·42
Fri...	30	2 47·48	0·350	2 47·47
Sat....	31	2 39·10	0·366	2 39·08

TO CORRESPONDENTS, &c.

N.B.—All Advertisements to be inserted in the Journal must be forwarded to W. HISLOP, Honorary Secretary, at the Office 35, Northampton Square, E.C. before the 23d of the Month.

All Communications for this Journal should be addressed to the EDITOR, *at the Office,* 35, Northampton Square, Clerkenwell.

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MECHANICS.

Fourth Lecture delivered to the British Horological Institute.

By W. Hislop, Esq., F.R.A.S., Hon. Sec.

December 31st, 1861.

(*Continued from page* 104.)

To illustrate the property of Inertia experimentally we have here an instrument, *fig.* 11, entitled a whirling table, a modification of one constructed by Ferguson. In this machine, rapid motion is given to two spindles, *a b*, and whatever may be placed upon them. If we place a disc of wood with an upright edge upon one of the

Fig. 11.

Fig. 12.

axes, and lay upon the disc an ivory ball, you will observe that when I commence turning the machine, the ball does not commence to move with the same rapidity as the disc. It however gradually acquires the same velocity from the friction which the disc exercises upon it; the ball now remains upon one part of the board, keeping the same rate of speed and having no relative motion with regard to it. It now illustrates the condition of bodies upon the surface of the earth, having the same motion as the earth, and therefore not moving from their relative places. If I stop the disc suddenly, the ball continues to revolve around the axis till the friction stops it, proving that matter would continue to move for ever if it met with no resistance.

The surface of this earth moves at the equator at the rate of about 1000 feet per second, and if we could imagine such a tremendous event to occur as the stoppage of the motion of the earth upon its axis, what awful desolation must at once occur. The ocean, seas, and lakes would rush from their beds, buildings of all kinds would be levelled with the ground and mingle their debris with the ruins of mountains and rocks, forests and woods, till the surface of this beautiful planet would be reduced to a state of wild and chaotic confusion. Nay more, the mass composing this globe would not bear the concussion; the force of inertia would overcome the forces of cohesion and gravity, the earth would fly into fragments which might form in the lapse of ages other and smaller planets, having their own motions and orbits around the sun, the great centre of attraction.

There exists in the solar system, a particular zone, which should, (in order to justify a remarkable theory, called Bode's law, held by astronomers, which points out the distance and matter of the various planets from the sun by mathematical reasoning), be occupied by a planet of a certain size and density or gravitating power. The absence of this large planet was for some time a difficulty, but by degrees, and especially of late years, a number of small planets have been discovered, occupying nearly the same orbit of revolution. These are called the "asteroids," and have been supposed at some period to have formed parts of one planet, revolving in its now comparatively vacant path, and by some such convulsion as we have just alluded to been rent into fragments.

Familiar examples of phenomena arising from the property of inertia are numerous.

When a carriage is once put in motion with a determinate speed, on a level road, the only force necessary to sustain the motion, is that which is sufficient to overcome the friction of the road; but at starting, a greater expenditure of force is necessary, inasmuch as not only the friction is to be overcome, but the force with which the vehicle is intended to move must be communicated to it. Hence we see that horses make a much greater exertion at starting than subsequently, when the carriage is in motion, and we may thus observe the inexpediency of attempting to start at full speed, especially with heavy carriages. When a carriage hanging from springs, first begins to move, the body of it appears to fall back, and a person within seems to be suddenly forced against the back cushion. When the carriage stops again, the body swings forward, and, if the stoppage be very sudden, a careless passenger may find himself looking through the front glass. If a passenger leap from a carriage in rapid motion, he will fall in the direction in which the carriage is moving at the moment his feet come to the ground; because his body on quitting the vehicle retains by its inertia that motion which it had in common with it. When he reaches the ground, this motion is destroyed by the resistance offered by the ground to the feet, but is retained in the upper and heavier part of the body, so that the same effect is produced as if the feet had been tripped.

Dr. Arnott relates some remarkable instances of the effects of inertia. An awkward rider on horseback may be left behind, when his horse starts off suddenly;—or he may be thrown off on one side by the horse starting to the other. A horse at speed stopping suddenly, often sends his cavalier over his ears, as was mortifyingly experienced by a coxcomb who chose to canter along a footpath, to the annoyance, of the company, and whose horse on hearing the word "halt!" loudly addressed to it by a waggish spectator, who knew its military history, suddenly stopped and thus got rid of its load. The will of the rider had sinned against the law of propriety, but his body very perfectly obeyed the laws of inertia and gravity, by shooting forward in a parabolic curve to the ground.

An amusing instance of the same law recently occurred at an inspection of a newly raised body of volunteer cavalry. Being mounted on their own horses, they were put through the ordinary evolutions of a field day, and the inspecting officer remarked that when halted suddenly at the charge the line was not well kept, many of the horses shooting beyond it. The excuse made by the commander was, that the horses not being under constant training were not so well in hand, or so precise in military movements as those of regular troops. The inspector apparently acceded to the justice of the observation, and remarked that a troop of regular cavalry would shortly be quartered in the neighbourhood, and he would then take an opportunity of doing more justice to the volunteers by inspecting them while mounted on better trained horses. The appointed day arrived, and the movements were executed with that marvellous amount of precision which is remarkable in a well-mounted body of horse. But the final evolution which was to crown the whole and reflect inextinguishable credit upon the newly-raised corps, was the one which had called forth the previous remarks. The regiment charged, and the line was kept with marvellous accuracy. The men sat their horses admirably, and the whole swept like a whirlwind across the plain. Suddenly the halt was sounded, the well-trained steeds, obedient to the sound and not needing the hand of the rider, stopped at once, but three-fourths of the riders did not stop, being propelled forward by their acquired momentum over their horse's heads, like sacks of flour, and deposited upon the sward, so many prostrate proofs that their own horses alone were not to blame, but that they themselves were not sufficiently alert to the word of command to oppose the necessary resistance to forward motion at the proper time.

A young man beginning to use the whip, drove his phaeton against a heavy carriage on the road, and then foolishly and dishonestly excused his awkwardness, in a way which led to his father's prosecuting the coachman for furious driving. The youth and his servant both deposed that the shock of the carriage threw them over the horses' heads, and thus they lost the cause by unwittingly proving that the faulty velocity was their own.

A person wishing to leap a ditch, first makes a run that the motion thereby acquired may help him over. A standing leap falls far short of a running leap. An African traveller found himself followed by a lion, from which he could not escape by running, but perceiving the animal was watching an opportunity to spring upon him, he led it to where the plain terminated in a precipice hidden by brush wood, and he had just time to transfer his hat and cloak to a bush, and to retreat a few paces when the animal sprung upon the bush, and by the motal inertia of its body was carried over the precipice and destroyed.

The actions of beating a coat or carpet to expel the dust, of shaking the snow from the feet by kicking against the door post, of cleaning a dusty book by knocking it against a table or shutting it violently, the knocking on the head of a hammer, adze, or pickaxe by striking the opposite end of the handle, are all illustrations of this principle.

The mercury of a common barometer on shipboard will be found to rise and fall in the tube with the motion of the ship, and until the important improvement of narrowing the tube in one place, to prevent this, the mercurial barometer was useless at sea.

If a cannon ball were to break in pieces in its flight, its parts would still continue to advance with the previous velocity. Thus also in the deadly contrivance of the shrapnell shell, which is a case containing hundreds of musket bullets, when these are let loose at the desired distance from the devoted body of men, they retain the forward velocity of the shell and spread death around, like the near discharge of a whole battalion of musketry.

Coursing owes all its interest to the instructive consciousness of the value of inertia which seems to govern the motions of the hare. The greyhound is a comparatively heavy body moving at the same or a greater speed in pursuit. The hare doubles, that is suddenly changes the direction of her course and turns back, at an oblique angle with the direction in which she has been running. The greyhound, unable to resist the tendency of its body to persevere in the motion it had acquired, is urged forwards many yards before it is able to check its speed and return to the pursuit. Meanwhile the hare is gaining ground in the other direction, so that the animals are a very considerble distance asunder when the pursuit is recommenced. In this way a hare though much less fleet than a greyhound will often escape it.

The quantity of inertia, or the momentum of a body, depends on its mass and velocity combined, the mass depending on the density of the body. Thus, a ball of wood has not the same momentum as a cannon ball, although moving with the same velocity, because it has not the amount of gravity or weight. Again the cannon ball, according to the velocity or quantity of motion in it, may have only the force or momentum that will bruise a plank, or it may have enough to penetrate a tree or even to pierce a block of the hardest stone or a mass of iron.

A block of wood floating against a man's leg with moderate velocity would be little felt, but a loaded barge, coming at the same rate would have power to break his bones, while a large ship would crush his body to atoms, and an island of ice, opposed in its approach to another even by a first rate man-of-war would destroy it, as meeting barges destroy a floating egg shell.

When bodies of equal mass meet together, the

draw it with it. I now place them at distances corresponding with their respective weights, the

THIRD LAWS OF MOTION.

(*To be Continued.*)

TABLES OF EXPANSION AND CONTRACTION OF WOODS AND METALS.

By R. Roberts, Esq., C.E.

TABLE I.

Amount of Expansion and Contraction for 1° (Fahrenheit) of the Wooden Rods, one foot in length, obtained at Temperatures between 44° and 80°.

Pine, St. John's.		Pine Varnished		Cedar.		Cedar Varnished.		Baywood.		Baywood Varnished.		
Expan.	Contrac.	Expan.	Contrac.	Expan.	Contrac.	Expan.	Contrac	Expan.	Contrac.	Expan.	Contrac.	
2036		2036		1583				2262		2941		Fine.
0932		0466		0932		0466		1165		1165		Dry.
0357		1431		0178		2772		0983		2146		Dull.
0281		1031		0469		1594		0562		2251		Clouc
3606		4964		3162		4832		4972		8503		
0901		1241		0790		1610		1243		2125		

TABLE II.

Amount of Expansion and Contraction for 1° (Fahrenheit) of the Wooden Rods, obtained at Temperatures between 54° and 90°.

Pine, St. John's.		Pine Varnished.		Cedar.		Cedar Varnished.		Baywood.		Baywood Varnished.		
Expan.	Contrac.	Expan.	Contrac.	Expan.	Contrac.	Expan.	Contrac.	Expan.	Contrac.	Expan.	Contrac.	
	3788		1836		6773		3444		6429		2525	Fu
	0366	1465		1343		1343			0366	2442		Fa
	1612	2357			1612	0992			1116	1861		Cl
0809		1214			0506	1417			0809	2125		Fa
	1895		0111		2898		0111		2786	0334		Fa
	2497	0000			2996		1098		3096		0998	Di
	2591		0585		3927		0919		3428	0585		Di
0809	12749	5036	2532	1343	18712	3752	5572		18030	7347	3523	
0809	2124	1259	0844	1343	3118	1250	1393		2575	1469	1761	

TABLE III.

Amount of Expansion and Contraction for 1° (Fahrenheit) of the Wooden Rods, obtained at Temperatures between 44° and 144°.

Pine, St. John's.		Pine Varnished.		Cedar.		Cedar Varnished.		Baywood.		Baywood Varnished.		
Expan.	Contrac.	Expan.	Contrac.	Expan.	Contrac.	Expan.	Contrac.	Expan.	Contrac.	Expan	Contrac.	
	0930	0500			3291				1359		0071	Rai
0575		1110		0123				1316		2385		Cha
	0538		0153		3461				1230	0153		Wet
	0911	0079			2696		1070		1030	0000		Dal
0575	2379	1689	0153	0123	9448		1070	1316	3619	2538	0071	
0575	0793	0563	0153	0123	3149		1070	1316	1206	0846	0071	

TABLE IV.

Amount of Expansion and Contraction for 1° (Fahrenheit) of the Wooden Rods, obtained at Temperatures between 34° and 134°.

Pine, St. John's		Pine Varnished.		Cedar.		Cedar Varnished		Baywood.		Baywood Varnished.		
Expan.	Contrac.	Expan.	Contrac.	Expan.	Contrac.	Expan.	Contrac.	Expan.	Contrac	Expan.	Contrac.	
1040		1226		0222		1114		1114		1709		Fa
1171		1405		0390		2108		1171		2030		Fa
0966		0966		0074		0966		0966		1709		Fa
3177		3597		0686		4188		3251		5448		
1059		1199		0228		1396		1083		1816		

TABLE V.

	General Roy.	Dulong & Petit.	Troughton.	Smeaton.	Lavoisier.	R. Roberts.
Glass, Flint . . .	04311	04788		04629	04509	05445
Steel	06359		06610	06805	05993	07719
Iron, Cast . . .	06170	06566		06988		07614
Iron, Wrought . . .			08000		06865	08474
Copper		09545	10660	09444	09569	12001
Brass			10660	10416	10370	13071
Tin					12072	17392
Zinc						19417

The first five Columns of this Table show the Linear Expansion of Seven metals for 1° (Fahrenheit), at Temperatures between 32° and 212°, extracted from the works of the Author named at the head of each column. The last column shows the same at Temperatures between 34° and 144°.

The figures in the first four tables require five cyphers to be prefixed to them, and those in the two last require four cyphers.

TABLE VI.

Average Linear Expansion for 1° (Fahrenheit) of the undermentiond Materials, at Temperatures between 34° and 144°.

Zinc, Cast	21177	Bagnall's Common Iron (W.) .	08539
Zinc Tube	17658	Daw's Best ditto (W.) . .	08488
Block-tin Tube	18621	Low Moor (W.)	08395
Block-tin, Cast	16164	Eglington, Clyde, & Glenarnock (C.)	07678
Muntz's Metal	13769	Langloan (C.I. No. 3.) . .	07686
Brass, Drawn	13499	Steel, Shear	07678
Brass, Watch	12643	Steel, Cast	07760
Gun Metal	12637	Langloan ditto (C.I.) . . .	07480
Copper, Cast	11995	Glass, Solid	05446
Copper Drawn	12007	Glass Tube	05444

TABLE VII.

		Class 1. 30° to 80°.		Class 2. 40° to 90°.		Class 3. 50° to 100°	
Zinc, Cast	Shear Steel ·	2·84	1	2·87	1	2·90	1
Zinc Tube	ditto	2·40	1	2·47	1	2·40	1
Block-tin Tube	ditto	2·40	1	2·64	1	2·95	1
Muntz's Metal	ditto	1·80	1	1·75	1	1·83	1
Drawn Brass	ditto	1·77	1	1·73	1	1·77	1
Watch Brass	ditto	1·66	1	1·60	1	1·66	1
Gun Metal	ditto	1·66	1	1·67	1	1·69	1
Zinc, Cast	Cast Steel	2·81	1	2·84	1	2·86	1
Zinc Tube	ditto	2·41	1	2·45	1	2·37	1
Block-tin Tube	ditto	2·41	1	2·61	1	2·92	1
Muntz's Metal	ditto	1·81	1	1·73	1	1·81	1
Drawn Brass	ditto	1·77	1	1·71	1	1·75	1
Watch Brass	ditto	1·67	1	1·58	1	1·64	1
Gun Metal	ditto	1·66	1	1·65	1	1·67	1

TABLE VIII.

	Zinc.	Block Tin.	Muntz's Metal.	Brass.	Gun Metal.	Copper.	Iron.	Steel.	Glass, Flint.
Zinc . .	1·00	1·11	1·41	1·48	1·53	1·61	2·40	2·51	3·56
Block Tin .	0·89	1·00	1·26	1·33	1·37	1·44	2·15	2·25	3·19
Muntz's Metal	0·70	0·79	1·00	1·05	1·08	1·11	1·70	1·78	2·52
Brass . .	0·67	0·75	0·94	1·00	1·03	1·08	1·61	1·69	2·40
Gun Metal	0·65	0·72	0·91	0·96	1·00	1·05	1·56	1·63	2·32
Copper . .	0·61	0·69	0·87	0·91	0·94	1·00	1·48	1·55	2·20
Iron . .	0·41	0·46	0·58	0·61	0·63	0·67	1·00	1·04	1·48
Steel . .	0·39	0·44	0·56	0·59	0·61	0·64	0·85	1·00	1·41
Glass, Flint	0·28	0·31	0·39	0·41	0·43	0·45	0·67	0·70	1·00

This Table shows the relative expansion of any of the Metals therein specified to any of the others. For example:—One foot of Flint Glass is equivalent to 0·28 of a foot of Cast Zinc, and *vice versâ*; one foot of Cast Zinc is equivalent to 3·56 of a foot of Flint Glass.

The Expansion has been ascertained in each case from experiments made on the same day; consequently the apparatus could not have altered materially between the compared experiments.

R. Roberts, C.E.

RATES OF CHRONOMETERS.

To the Editor of the Horological Journal.

Sir,—The Horological Institute having a Standard Mean Time Clock, accurately kept to Greenwich time, by means of the communication with the Royal Observatory, through the electric telegraph, which transmits a time signal twice daily, now possesses efficient means for rating chronometers and watches or clocks which are compensated for the effects of temperature. It may therefore not be unacceptable to consider the method by which the instruments may be compared with the standard and their performance satisfactorily tabulated, with a view of exhibiting errors and rates, with the circumstances under which they are obtained.

If many instruments are to be rated, it will be necessary, for the purpose of saving time and labour, to compare them with the standard, as nearly as possible at the same hour daily. The following form appears simple and concise, but amply sufficient for the purpose of these comparisons.

Day of the Month	Clock fast on Greenwich Mean Time	Name and No. of Chronometer			
		For 0 seconds of Chronometer		Chron. daily Gain	Mean temperature From Max. & Min. Thermometer
		Chron. hr. & min. / Clock, hr., min., & sec.	Solar seconds		
	s	h m 0 16 / 0 20	s	s	°
		s			
1	2·9	37·8	34·9	—6·7	49
2	2·6	43·3	40·7	—5·8	56
3	2·3	50·0	47·7	—7·0	50
4	2·1	56·2	54·1	—6·4	47
5	2·0	2·0	0·0	—5·9	53
6					

The clock error, found daily at the same hour from the time signal, is entered in the

column, with a minus sign if the clock is losing.

When the chronometer is compared for the first time, or on the first of the month, the clock seconds (noted to the nearest tenth), corresponding to an even minute of the chronometer, are entered in the 3d column, and the hour and minute of the chronometer noted at the top of the column; with the hour and minute of the clock placed underneath. The hour and minute need not be repeated for the rest of the month. The clock seconds are to be corrected for the clock error and placed in the 4th column, headed "solar seconds." The difference from day to day, of the solar or true seconds is placed in the 5th column.

It is evident that if the differences increase, the chronometer is falling behind true time, or losing:—the minus sign is then to be affixed. When the chronometer gains on true time no sign need be used.

Lastly, the 6th column is for a record of the temperature from a self-registering maximum and minimum thermometer during the preceding 24 hours. Both temperatures, or their mean, may be shown as desired. Space may be ruled for three or more chronometers on the same page, but the two first columns need no repetition. In such a table the variation of the rate, and likewise of the temperature, are seen at a glance. The error is seen almost as easily. A simple subtraction gives it us. Thus on the 3rd (in the above table) the error is 4m. 47·7s. slow. On the 5th the minute of the clock has altered and become 21; looking out for such changes, the chronometer is seen to be 5m. 0s. slow.

The following form, used in the Liverpool Observatory, affords a valuable record for chronometer statistics. It places together, so as to be comparable, the performances of various chronometers; shows the effect of change of rate on the longitude; and leads to the detection of the cause, if it be from inefficient compensation for temperature. The minus sign is used as before, to indicate *slow* of Greenwich time, or *losing* rate.

CHRONOMETERS RECEIVED.

Month and Day.	Name of Chronometer.	Name of Ship.	Name of Commander.	Fast of Greenwich Time	Rate on Voyage Gaining	Error in Longitude	No. of Days.
1853.				h. m. s.	s.	s.	
Jan. 10	M. 300	Bellona	Jump ...	0 42 24·5	2·83	E. 145.	140
,, 14	F. 402	Constellation	Allen ...	0 15 25·2	—0·77	E. 29.	107
,, 15	T. 633	Wales	Lambert	—0 53 17·6	—4·73	W. 12.	44

CHRONOMETERS DELIVERED.

Month and Day.	Fast of Greenwich Time.	Mean Daily Rate Gaining.	Greatest difference between any two days.	No. of Days.	Range of Mean daily Temperature.	REMARKS.
1853	h. m. s.	s.	s.		° °	s. ° s. °
Jan. 27	0 43 7·0	2·50	3·5	17	47 to 79	Gains 1·7 in 52 and 4·3 in 78
Feb. 11	0 13 54·4	—3·23	6·6	28	44 to 79	Rate irregular in the same temperature.
Feb. 14	—0 56 12·7	—5·87	3·8	30	42 to 69	Loses 7·2 in 43 and 4·0 in 65

The above is perhaps sufficiently explanatory without any comment; but it may be advisable to show by an example how the "error in the longitude" is obtained.

When a chronometer has been previously rated, the old "rate paper" is generally deposited in the box, and accompanies the instrument; and from it the necessary data is obtained.

Suppose then, that such a paper stated that on October 30th, 1856, a chronometer was slow of G. M. T. 3m. 23·7s. and losing daily 0·8s.; and when received by the rater on August 14th, 1857, its real error was

5m. 31·5s. slow; what would have been the error in longitude if this rate had been allowed for during the interval?

		h.	m.	s.
Accumulated rate	= 288 days × 0·8s.			
,, ,,	=	0	3	50·4
Oct. 30th, slow	=	0	3	23·7
Aug. 14th, supposed slow		0	7	14·1
,, really ,,		0	5	31·5
Gain on rate		0	1	42·6
i.e. Error on longitude				102·6 w.

The error in longitude is West, because the computed rate would have made a meridian to the Eastward of Greenwich the first meridian, but as the navigator would find his position on the chart from the meridian of Greenwich the ship would be considered to the westward of her *true* place.

R. Strachan.

ARTISTIC BOTANY: ITS APPLICATION TO THE LAWS OF ORNAMENTATION.

By Dr. C. Dresser, F.L.S., F.E.B.S.

Lecturer at the South Kensington Museum, the Crystal Palace, the Polytechnic Institution, and the Metropolitan Hospitals.

Third Lecture.

Delivered for the British Horological Institute, *at the Parochial School Rooms, Amwell Street, Clerkenwell, on the Evening of February 21st,* 1861.

(*Continued from page* 22.)

Last week I stated, that before proceeding to the special subject of this lecture, I would refer again to a particular point which we were then considering. It will, however, be desirable that I should refer to a communication, which I have received from your Secretary, who has kindly sent me copies of your Journal, one of which contains a very admirable paper on Decoration; and another on the results of a Discussion upon a subject to which my special attention was turned, namely, As to what are the best patterns for engraving watches. From having already expressed my opinion on the latter subject, it would be folly in me to enter at any length into it; I have commented upon the various grades of art, and have given illustrations of them, from the lowest, or mere adaptation up to the highest of purely mental development, in which the most mind is manifested. During the remarks, in the Discussion to which I refer, it was said that there is a great effort made by some parties to imitate light and shade. Now I regard that as a similar mistake to that of the making water vessels in the shape of wicker work, to which I referred last week. It is an effort to do what cannot be done with the same amount of success as it can upon a common piece of paper, where it can be performed with the greatest ease; but, engraving on metal, can effect what cannot be produced on paper. In gold, you have a beautiful material to deal with; and therefore, I consider that it is a step in the wrong direction to try and do that badly upon metal which is capable of being well done upon other materials. The question may be resolved into this—What sells best? but such an Institution as yours should endeavour to raise the national taste. It is the peculiar prerogative of some individuals to be so far in advance as to be capable of taking the lead, and such should be your position.

Allusion was also made in the discussion as to the necessity for the ornamentist learning drawing. That I think must be obvious to every one; but with regard to the power of drawing, I would observe, that it is only a means to an end. No student intended for art drawing is transferred to my tuition until he has acquired the power of image drawing to a very great extent. We never think of entering them in the higher class, until they are well able to draw perfectly from nature, flowers, fruits, and other objects suited to ornamentation and design. It is indispensable that they should be thoroughly skilled draughtsmen, before they think of becoming designers. To my mind, the analogy runs thus: drawing is absolutely necessary for ornamentation. No one would think of denying that fact; but it does not follow that because a person can imitate well that he will, therefore, be able to produce an original design. At school a boy may be taught his alphabet, be taught to write and understand English composition; but he would not, therefore, be enabled to produce Essays like Macaulay's when he left it. He has learned to read and write certain words, simply as a means to an end. We teach him the laws of composition, and cultivate his mind so as to enable him to produce beautiful ideas. Drawing is to the student in art, the same as writing is to the scholar in literature, the means of enabling him to convey the thoughts of his mind; it is the mind after all which must produce the design. As to the power of mere imitation, we know that it is possessed by certain animals. We have heard of the mocking bird for instance, which can imitate very nicely, but it has no mental development notwithstanding. A

monkey, again, will imitate the actions of a man, but it is not a man for all that. It is mind which peculiarly distinguishes men from mere animals. In engraving upon gold you can use light spots which are always beautiful.

Last week, I referred to the flounce which one of our students in the Female School of Art, Queen Square, has received a commission to prepare for the wedding dress of the Princess Alice. Every part of its design is based upon certain laws, and the result is, that not only has the composition proved highly satisfactory in that particular case, but the same student has been further commissioned to design a veil of a very costly character, and Her Majesty has also ordered for herself a flounce constructed upon the same broad principles, but differing somewhat in details from that of the Princess Alice.

Symbolism is the power of speaking which every thing enjoys. There is sometimes a deep set meaning in the form used in ornament. For example, if we go into an Egyptian temple, we find a continual repetition in its embellishments of the lotus, or that form of vegetable growth which is known to the artist under the name of the lotus. This plant conveyed a particular meaning to the mind of the Egyptian. The lily was the first flower to spring up after a rainy season, when the Nile had overflown its banks, depositing upon the land a quantity of rich earth. Just as the waters are settling again into the bed of the river, the husbandman casts his seed upon the water, and it shortly springs up an abundant crop, but before it does so, the lotus appears as the harbinger of good. That flower, was therefore, used as the precursor of good tidings, and thus it became an object of worship. The Egyptians also held in religious veneration mice, rats, and things of that kind. So in various parts of the earth, the same thing has been done at different periods. Almost every part of Gothic architecture had originally a particular meaning. There are a number of plants which were supposed to have a special signification. Linnæus constructed what he called "The Floral Clock," which runs thus—

FLORAL CLOCK.

	Hours of Waking
Major Convolvulus	2 a. m.
Ipomara Nil and Wild White Convolvulus	3—4 „
Yellow Goatsbeard and Wild Camomile	4—5 „
Naked Stemmed Poppy and Wild Succory	5 „
Minor Convolvulus, Dandelion, Ecballium, Claterium, and Common Lapsane	5—6 „
Spotted Cat's Ear, several species of Solanum, and Convolvulus Siculus	6 „
Sow Thistle, and a species of Hieracium	6—7 „
Water Lilies (many species) Lactuca, Camelina, and Prenanthes Muralis	7 „
Small Cape Marigold, Bearded Fig, Marigold, Specularia Speculum, and Cucumis Angurica	7—8 „
Scarlet Pimpernel	8 „
Nolana Prostrata	8—9 „
Field Marigold	9 „
Sandworts	9—10 „
Knotted Fig Marigold	10—11 „
Common Star of Bethlehem (Dove's Dung of Scripture), and Lady Eleven o'Clock	11 a. m
Blue Passion Flower and many Fig Marigold	12 „
Scilla Pomeridiana (at Montpelier)	afternoon
Squill and a species of Feverfew	2 p. m.
Night Flowering Catchfly	5—6 „
Evening Primrose	6 „
Marvel of Peru	6—7 „
Evening Flowering Lychnis	7 „
Œnothera Tetraptera, and Enaveolen, and Night Blooming Fig Marigold	7—8 „
Night Blooming Cereus	8—9 „

The Ornithological Clock is a modification of the same idea. It is constructed so as to mark the hours by the time of awakening of the little feathered songsters. It is constructed on the principle of the Flower Clock, by a German woodman. It is intended to mark the hours by the waking of the first notes of the little songsters of the woods. The signal is given by the green chaffinch, the earliest riser among all the feathered tribes. Its song precedes the dawn, and is heard in summer from half-past 1 to 2 o'clock, a. m. Next from 2 to half-past 3 comes the black cap, or the *sylvia atricapilla*, whose warblings would equal those of the nightingale, if they were not so very short. From half-past 2 to 3 the hedge sparrow. From half-past 3 to 4 the blackbird; the mocking-bird of our climate, who imitates all tones so well that the blackbirds of a French Canton were made to sing the Marseilleise Hymn,, by letting loose a blackbird who had been taught that tune. From 4 to half-past 4 the lark pours forth its melodies. From half-past 4 to 5 the black-headed titmouse is heard. Lastly, from 5 to half-past, the sparrow wakes and begins to chirrup.

Another modification of deep interest is "The Flower Clock," (*Horologium Flora*), of Linnæus in Upsal, the wheels of which are the sun and the earth, and the index fingers of which are flowers, one of which always wakens and opens later than another, and this suggested the conception of the lunar clock. Richter says, "I formerly occupied two chambers in Scheeran, in the middle of the market place. From the front room, I overlooked the whole market-place and the royal buildings, and from the back the botanical garden. Whoever now dwells in these two rooms passes (exceedingly harmoniously arranged to his hand) between the flower clock in the garden and the lunar clock in the market place. At 3 o'clock in the morning the yellow goats-beard opens, and the stable boy is to rattle and feed the horses beneath the ledger. At 4 o'clock the hawkweed awakes, choristers going to the cathedral, who are clocks with the chimes and the bakers. At 5, kitchen-maids, dairy-maids, and butter-cups awake. At 6, the sowthistle and cocks. At 7 o'clock many of the ladies' maids are awake in the palace, the chicory in my botanical garden, and some tradesmen. At 8 o'clock all the colleges awake and the little yellow mouse-ear. At 9 o'clock the female nobility begin to stir, the marigold, and even many young ladies who have come from the country begin to look

out of their windows. Between 10 and 11 o'clock the court ladies, and the whole staff of lords of the bed chamber; the Alpine dandelion; and the readers of the princess arouse themselves out of their morning sleep, and the whole palace, considering the morning sun gleams so brightly to-day from the lofty sky through the coloured silk curtains, curtails a little of slumber. At 12 o'clock the prince, at 1 his wife, and the carnation, have their eyes open in their flower vase. What awakes late in the afternoon, at 4 o'clock is only the red hawkweed. In the night, watchmen see the cuckoo clock, and these two only tell the time as evening clocks and moon clocks. I could never know when it was 2 o'clock, because at that time together with a thousand other city gentlemen, and the yellow mouse-ear, I always fell asleep; and at 3 in the morning I awoke as regular as though I was a repeater.

It would, perhaps, be useless to show you how flowers are used to typify the seasons of the year. Such things are frequently done in illuminated almanacs, but they are not clocks; yet still they are sometimes associated with timekeepers in various ways. I will give you one or two instances of the typical use of flowers for such purposes. There are the symbols of the months: January, Christmas rose and winter aconite. February, snowdrop and crocus. March, primrose and wood anemone, and oats are sown. April, fruit blossoms, the narcissus, cowslip and bluebells. May, strawberry blossoms, hawthorns, honeysuckle, buttercup, daisy, lilac and laburnum. June, dognose, pimpernel, bonage, mushrooms appear, haymaking. July, white lily, harebell, sun flower. August, chinaasters, garden balsams, oats, barley, haricots, hop-picking begins, the leaves of the wheat turn yellow. September, blackberries ripe, apples ripe, honeysuckle blossoms a second time, dry flowers. October, strawberry-tree flowers, acorns ripe, hedge-nuts, hawthorn berries, low-berry fruit. November, the fall of the leaf, land ploughed. December, misletoe in fruit, holly in fruit.

Colour is applied to watch-cases chiefly for ladies by enamelling, and the laws that regulate it are of very great interest. Not one person in ten uses colour correctly. This, perhaps, may arise from the fact that persons see them differently. I know two or three persons who are blind to colours, although they are very keen sighted in many other things. The first instance of this description which I met with struck me as very peculiar. I asked a friend of mine the colour of one or two gems; the colours of which I was unacquainted with. He replied, "I really do not know what their colours are." I rejoined "You a jeweller and not know the colours?" "No," he said, "such is the fact." There happened to be laying on the table a green card case and a red telescope case. I asked him if he knew of what colours they were; he replied that he did not. So it may be and probably is with other persons, one colour may seem to one very different to what it does to another. Many differences of opinion as to the effect produced by colour may be explained by that phenomenon. If there is anything radically wrong in our views of a subject, it probably arises from that cause. The source of colour is light. That is the first fact to which I must call your attention. The next is, that light consists of three colours,—yellow, red, and blue. By their mixture or combination all other colours are produced. For instance, if we mix blue and yellow together we obtain a green, as you all know perfectly well. An artist very rarely has any green paint in his box. If red and blue is mixed together it forms a purple; and red and yellow produce an orange. You may tell me that Sir Isaac Newton taught us that there were six colours, which he thus made—violet, indigo-blue, green, yellow, orange, and red. Supposing a ray of light was let into a room through a small opening and passed through a prism, or three-sided glass, it would not proceed straight, but would be bent back again; instead of continuing in a downward direction, it would be divided into a given number of parts, and what were called "the colours of the rainbow" would be depicted by it. Sir Isaac Newton found that the top was violet, the next blue indigo, the next blue, the next green, the next yellow, the next orange, and the lowest red. A ray of white light may be said to be represented by rays of light possessing those colours. As the light is the source of all colours, so it is itself made up of so many colours, combined together the sum is light. In passing through the prism the blue is bent more than the yellow, the yellow more than the red. The blue ray falls upon the surface; the red ray falls upon the top of that; and the yellow ray again falls upon the top of that. Those three rays falling on the top of each other produce white. By such an arrangement we are enabled to cast a blue ray of light on one side, a yellow ray of light on another, and a red upon another; so that the whole instead of falling one on the top of the other produces a white light. Now, again, they are separated, shewing you the three component parts. If the colours instead of falling upon a plain surface, fall upon a concave reflector, they are reflected back, showing the three colours of light; then reversing it all the colours will meet at a given point and become white again. It was by overlapping the blue and the yellow that green was obtained; and it was by overlapping the parts communicating together that the seven colours are produced. The red, blue, and yellow are parts of the same primary colours. If a blue ray is passed through a prism, it remains blue wherever it falls. Pass it through anything else that has no colour in it, and we cannot resolve it into any thing else but a blue ray. These stand in the same relation to colours as the elementary bodies do to chemistry, or the stars of the firmament to astronomy.

Paints represent what exists in light. There is it is true a great difference between the two. Here I have a blue colour, but I should be very sorry to say that it represents exactly the same colour which exists in light; but it is as near as I can get it. The same remark applies to the other colours, none of them are exact representations of the real colour. Some of the pigments of paint are transparent and others opaque. They differ very materially in their chemical compositions as well as in their physical nature. The

differences arise from the variations in the pigments. These paints do not represent truly the colours of the rainbow, and therefore it is impossible for me to produce the same effect all through. If we got three absolutely pure colours we should want no others. The artists' box would be complete with them alone; but not having got them we are obliged to imitate them. Then there are other difficulties. The pigments will sometimes mix so as to destroy each other. I have just said that white is composed of three colours, red, blue, and yellow. If I could mix them as I have them here without destroying them, the same as I do by the agency of prisms and reflectors, I should get a pure white light; but, supposing I select three of the brightest of blue, yellow, and red which I can get, and mix them together in certain proportions I get a colour which is all but black. Many artists never use black; they have none of it in their paint box; but they compound it of three colours. That results from the fact that the paints when mixed together destroy one another. That is a feature in the law of colours to be borne very specially in mind when mixing colours; that the more you mix them the duller they become. By a mechanical arrangement, I can give you some illustrations of the fact. I have here three what are termed secondary colours—green, purple, and orange. The purple constitutes a red, the blue standing midway between them. Green is a mixture of yellow and blue; orange, of red and blue Each of the secondary colours results from a mixture of two primary ones. By the agency of this wheel I can mix them without destroying them. Directly I mix those I have here, I get a grey approaching to a white, and it would be absolutely white if I had the three colours. red, blue, and yellow, as pure as they exist in light. The means I have used for bringing about the result is this: the eye cannot forget what it has seen in less time than the tenth part of a second. By acting upon that fact, engineers are often enabled to accomplish apparent marvels. The spectator might as well be blind altogether. A school boy knows that if he can get a stick and a string at the end of it and whirl it round, he will soon get a form of a circle, an effect produced from the same cause. The eyes cannot occupy two spaces at once. (The Lecturer then illustrated the formation of compound by the combination of simple colours) Such experiments must be tried if you wish to become conversant with the mixture of colours. There is a little arrangement sold for a shilling which has all the colours of the rainbow according to Sir Isaac Newton's plan. Another arrangement is upon the principle of the humming-top; it is called the Philosopher's Top.

In lecturing I always wish to show the mode of carrying out the experiments in the most simple manner, so that they may be repeated by my auditory. It is great folly in teaching to employ costly mechanism. It is our business as tutors to try and illustrate in such a plain manner that our pupils may repeat what we have done, and see whether it is so or not.

Although I have just called your attention to these facts, you must bear in mind specially that really in a scientific point of view there is no colour in any thing. That seems a very startling proposition when stated for the first time, that the papers which you see apparently red and blue are really of no colour at all. A ray of light consisting of red, blue, and yellow, falls upon these surfaces. The red paper has the power to suck in all the blue and yellow rays, and thus destroys them; and reflects back the red only. So with the others. When light falls upon a looking glass, it is reflected back, but not quite all of it; but when the light falls upon those other surfaces, the blue and yellow are sucked in and the red remains and is reflected. The same with the blue and yellow. A purple surface such as I have here is found thus: it has a power of sucking in and destroying the yellow, sending back the red and blue, which in combination form purple. It is the same with other colours. There is a great desire in the mind for the presence of three colours—red, blue, and yellow, in the proportions of three parts of yellow, five red, and eight blue. In those proportions they are beautiful and harmonious. You may illustrate this fact thus. Get a copy book cover and cut it through. The inside is perfectly white. Put between them tissue paper or something thin. If you gaze for some time upon the blue so that it may fatigue the eye, one part will no longer appear white, but orange. We have the blue here, and the mind has created the orange colour opposite to it. The orange is a mixture of yellow and red which have been created bythe mind, showing at once you see, a natural effort on the part of the mind to produce those three colours in order to give itself pleasure. If I place in a sheet of red, and gaze at it for some time, I notice that the bars become green. Green is what we term a complimentary colour; the red being composed there of two primary colours, so when green is used those two colours are produced. This is a very singular experiment; and I am sure you would have great pleasure in pursuing it for yourselves from that thoroughly scientific toy which I have here.

I will just say a word about the power of colours. Blue is the most retiring; supposing you were dealing with the walls of a room and wanted to make it look larger, blue should be the predominant colour you employ. There is no doubt that that is why the sky appears blue. Of all colours red is the most exciting; and that is the reason why we dress our soldiers in it. I think that is a great mistake in our army regulations. If I was a soldier I should be very sorry to be dressed in red. The colour of birds is almost always according to the circumstances in which they live. Those which live amongst ferns and withered vegetation have very much of the same brown colour; so that you may very often mistake a bird for a dead leaf. If the soldiers were of the same colour as the ground on which they were, or of the grass amongst which they moved, it would be much more difficult to shoot them than it is now. Of all colours, yellow is the most advancing, so that if you do not want a thing to look large, never paint it of that colour. Then look how they are contrasted. Red and green are what we call complimentary colours. If you want red with one, you must have green

with the other because that is a primary colour. But then you produce a contrast in this way;—green is comparatively soothing whilst red is exciting. There is no difference as regards depth; they are very nearly the same. The contrast produced is from the exciting effect of the one and the soothing influence of the other. That is why grasses and vegetables are green. You deal with purple and yellow as complimentary colours. There are three colours contained in them. Yellow is advancing, but purple is retiring, blue is the most retiring of all, but nevertheless purple is retiring. Purple again is a dark and yellow a light colour; so that you have the contrast again of light and dark. If you take an orange and blue, there is also a contrast, the orange being an exciting or stimulating colour, whereas blue is the most retiring of all colours.

METEOROLOGICAL OBSERVATIONS,

Taken at 9 A.M., April 1862.

Gray's Inn Road.

Remarks.

The maximum height of the barometer was 30·33 at 8 a.m, 29th; the minimum 29 58 at 11h 30m p.m., 2nd; also the same at the same time on the 22nd.

Rain fell on 14 days, during about 80 hours, to the amount of 2·34 inches.

The 9 a.m. wind observations referred to the cardinal points shew W winds on 13 days; N, 8; E, 4; and S, on 5.

EQUATION OF TIME TABLE

For June, 1862.

Day of the Week.	Day of Month	At Apparent Noon. — Equation of Time to be *subtracted* from Apparent Time.	Difference [illegible] One Hour.	At Mean Noon. — Equation of Time to be *added* to Mean Time
		m. s.	s.	m. s
Sun...	1	2 30·31	0·383	2 30·29
Mon..	2	2 21·13	0·399	2 21·11
Tues..	3	2 11·56	0·413	2 11·56
Wed..	4	2 1·68	0·426	2 1·67
Thurs.	5	1 51·45	0·439	1 51·44
Fri...	6	1 40·91	0·451	1 40·90
Sat...	7	1 30·08	0·463	1 30·07
Sun...	8	1 18·96	0·477	1 18·95
Mon..	9	1 7·59	0·484	1 7·59
Tues..	10	0 55·98	0·493	0 55·97
Wed..	11	0 44·15	0·502	0 44·14
Thurs.	12	0 32·11	0·510	0 32·10
Frid..	13	0 19·89	0·517	0 19·89
Sat...	14	0 7·49	0·523	0 7·49
		added to		*subtracted*
Sun...	15	0 5·00	0·528	0 5·06
Mon..	16	0 17·74	0·533	0 17·74
Tues..	17	0 30·54	0·538	0 30·54
Wed..	18	0 43·45	0·541	0 43·44
Thurs.	19	0 56·41	0·542	0 56·40
Fri...	20	1 9·41	0·543	1 9·40
Sat....	21	1 22·44	0·544	1 22·43
Sun...	22	1 35·49	0·543	1 35·48
Mon..	23	1 48·51	0·540	1 48·49
Tues..	24	2 1·46	0·537	2 1·44
Wed..	25	2 14·33	0·532	2 14·31
Thurs.	26	2 27·10	0·526	2 27·08
Fri ...	27	2 39·72	0·519	2 39·70
Sat....	28	2 52·18	0·512	2 52·16
Sun...	29	3 4·46	0·503	3 4·44
Mon ..	30	3 16·53	0·492	3 16·50

ERRATUM.

In the list of Donations in our March No. "Lake Hansard, £1 : 1 : 0," should have been "Luke Hancock."

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THE BRITISH HOROLOGICAL INSTITUTE.

THE ANNUAL MEETING.

The Annual Meeting was held at the Institute, on Wednesday the 25th ultimo, at Seven o'clock in the Evening, Mr. Klaftenberger, as one of the Vice-presidents, occupying the chair.

The minutes of the previous Annual Meeting were read and confirmed, with certain amendments which were ordered to be made in them.

Mr. Hislop, the Honorary Secretary, read the following Report and Financial Statement:—

"Report of the Council for the Year ending June, 1862.

"In conformity with the rules, the Council beg leave to present for the consideration of the Members, a Report of the state and proceedings of the British Horological Institute, with an audited Financial Statement for the past year.

"The universal depression of industrial arts, and the especial manner in which that depression has borne upon Horology, has produced some effect upon the Association as respects the number of Members and the consequent income.

"The difference is not so great, however, in point of number, as might have been expected, while the income has been made up from other sources to an amount nearly equal to the previous year.

"Your Council is gratified to be able to announce that one of these sources is the Journal of the Institute. It has gradually won its way into notice, and its value as a record, and as a permanent advertising medium is becoming so much understood, that it not only pays its own expenses, and enables each member to be supplied with a copy, but has also added £40 to the income of the Institute during the past year.

"Your Council take this opportunity of pointing out to Members the desirability of still further aiding the funds of the Institute, by circulating the Journal among their friends, and also by recommending as well as making use of it as an advertising medium.

"In order to preserve the accounts in a satisfactory state for the future, it is proposed that each should be balanced monthly, so that the position of any department may be observed by simple inspection.

"In conclusion, your Council earnestly call upon Members to give their assistance in transacting the business of the Institute.

"The work now falls so heavily upon a few Members, as to make it impossible for them to continue in office without further help.

"Hoping that all parties will unite in giving their assistance, and expressing the conviction that union will enable the Institute to fulfil its objects efficiently, they render into your hands the office they have held during the past year."

Statement of Receipts and Expenditure from June 1861 to June 1862.

Dr.	£.	*s.*	*d.*
To Balance in hand, at last audit ...	31	11	0
„ Donations and Subscriptions ...	233	10	0
„ Cash for Journals	46	5	11
„ Ditto for Advertisements... ...	81	7	4
„ Sundries, Dinner and Lecture Tickets, Class Admissions, &c. ...	35	19	1
„ Rent received from Mr. Palmer...	20	0	0
„ Petty Cash Balance	0	14	0
	£449	8	0

Cr.	£.	*s.*	*d.*
By Rent, Taxes, and House Expenses	95	1	10
„ Salaries, Wages, and Commission	92	7	0
„ Printing, Engraving, and Binding Journals	98	7	0
„ Disbursements at Annual Dinner	42	8	0
„ Printing, Advertising, &c. ...	30	4	6
„ Newspapers, Periodicals, &c. ...	13	14	10½
„ Stationery, Stamps, and Account Books	13	7	3½
„ Drawing Master's Fees ...	19	13	0
„ Mr. Palmer, care of Premises ...	20	18	0
„ Marine Chronometer for Museum, and Sundries	12	3	9½
„ Balance in hands of Hon. Sec. ...	11	2	8½
	£449	8	0

We have examined the Balance Sheet, together with the Accounts for the current year, and find the same to be correct.

(Signed) Henry G. Webb, John Evans } *Auditors.*

Mr. E. D. Johnson, as a Vice-President of the Institute, thought it was the duty of one of those officers to move the adoption of the Report. If their President, Mr. Valentine Knight, had been present, no doubt he would have performed the duty which he (Mr. J.) rose to discharge. Mr. Knight had however been prevented from attending by a previous engagement. The adoption of the report ought to be moved by an officer of the Institute, because in the first place it was not simply bearing testimony to his belief of the accuracy of the figures and the correctness of the statements made by it respecting the affairs of the Institute, but it also afforded an opportunity of recommending what he took the liberty of doing then, that the report should be adopted, even though it should not seem to them quite so satisfactory as circumstances might have warranted. The accounts afforded what every member and officer of the Council had felt the want of, namely, a new starting point, which had become a positive necessity, from the

difficulties in which the late Assistant Secretary had involved the accounts. These difficulties had been enormous. Nothing but a better system would enable the Honorary Secretary to lay, from time to time, such statements before them as the members might desire to see. It was true the Institute was rather peculiarly situated with regard to its members. He believed that in that respect it was in a far worse position than any philosophical institute in London. In other cases, the welfare of the institution was an altar upon which the members reverently laid their offerings, whereas the majority of the members of the British Horological Institute came to fetch and not to bring. They seemed to attach themselves to the Institute as much for what it could do for them, or more, than for what they could do for it, which he maintained was not the right, true, and proper feeling which should prompt the members of philosophic institutions. He might take up their time by citing illustrations and facts connected with other philosophical institutions in proof of what he had said. He merely offered these as passing remarks, as an additional reason why they should give the Institute by the adoption of that report, a starting point to manage the business of the Institute from properly; one so simple that if it was desired —although they did not admit it to be necessary —they could give information upon any given point that might be required.

Mr. Blackie seconded the motion, which was put and carried unanimously.

Election of Officers.

The Ballot having been kept open from Seven to Nine o'clock, the following Gentlemen were declared by the Chairman to be elected unanimously, no other candidates having been opposed to them.

President:

Valentine Knight, Esq., 3, Cornwall-terrace, Regent's Park.

Vice-Presidents:

J. F Cole, Esq., 11, Great James-street, Bedford-row.
Chas. Frodsham, Esq., F.R.A.S., &c., &c., 84, Strand.
C. J. Klaftenberger, Esq., 157, Regent-street.

Treasurer:

G. Blackie, Esq., 24, Amwell-street.

Honorary Secretary:

W. Hislop, F.R.A.S., 108, St. John's-street-road.

Council:

Birchall, W. P., 2, Amwell-terrace.
Brooks, S. A., 10, Northampton-square.
Crisp, W. B., 82, St. John's-street-road.
Gordon, Theo., 26, Great James-street, Bedford-row.
Guillaume, C., 16, Myddleton-square.
Holdstock, T. W., 25, Percival-street.
Jackson, S., 66, Red-lion-street.
Johannsen, A., 38, Holford-square.
Johnson, E. D., F.R.A.S., 9, Wilmington-square.
Jones, John, 338, Strand.
Knight, F. W., 11, Upper Smith-street.
Kulberg, V., 12, Cloudesly-terrace, Liverpool-road.
Leonard, Thomas, 50, Tabernacle-walk, Finsbury.
Marriott, B., 38, Upper-street, Islington.
Morton, Geo, 31, Hanover-street, Islington.
Murray, —, Wood-street, King's-square.
Mylne, G. E., 2, Great Percy-street.
Richards, H., 2, Butler's-place, Pentonville.
Roberts, Richard, C. E., 10, Adam-street, Adelphi.
Storer, Egt., Upper Barnsbury-street.
Strachan, R., 7, Arthur-street, Gray's-inn-road.
Tilling, J. L., 1, Elizabeth-terrace, Liverpool-road.
Trewinnard, J., 40, Providence-row, Park-road.
Walsh, A. P., 46, Wilmington-square.
Warman, J. R. 49, Spencer-street.
Watson, J. F., 7, St. John's-square.
Webb, Henry G., 159, St. John's-street-road.
Webster, R., 74, Cornhill.

Alteration of General Meeting from Half-Yearly to Annual.

Mr. Hislop moved the following resolution, pursuant to notice:—

"That the word "annual" be substituted for the words "half-yearly" in the first rule of the fifth section of the Laws; and that the words "and December" in the same rule be expunged.

"Also, that the word "annual" be substituted for the words "half-yearly" in the fourteenth and fifteenth sections."

His object was to make the rule correspond with the practice. On examining the minutes he found they did not exactly specify whether the meeting was to be annual or half-yearly. It had been taken for granted, that the meeting as well as the election, was to be annual instead of half-yearly.

Mr. Walsh seconded the resolution.

Mr. Jackson drew attention to the fact that by the rules no alteration of laws could be made unless thirty members were present, the meeting wanted one of that number.

The motion was held over for the present.

Election of Honorary Members.

Mr. E. D. Johnson moved, in conformity with a notice he had previously given to that effect, that Lord Wrottesley and Vice-admiral Manners should be elected honorary members of the Institute. It was due to the members of the horological art to pay something like a compliment to that nobleman and the gallant admiral, concerning whom he (Mr. J.) begged to testify that they had worked most assiduously and carefully, with every desire to act impartially as jurors of the Horological Department, Class 15, of the International Exhibition. He did not think they could do less, and he regretted they could not do more than that.

Mr. Mylne having seconded the resolution, it was passed unanimously.

The Chairman having stated that it was necessary to appoint Auditors for the ensuing year, Messrs. C. Bacon, J. Evans, D. Gunton, and W. Schoof were proposed and elected unanimously.

Mr. Jackson said that the agreeable duty had fallen to him of proposing, "That the thanks of the meeting are eminently due and are hereby tendered to Mr. Valentine Knight, our esteemed President, for his valuable services during the past year." It was unnecessary to say half-a-dozen words in support of the motion, because he knew how thoroughly the members of the association esteemed Mr. Knight, who was well known and highly respected, not in the Institute alone, but throughout Clerkenwell. He hoped that they might again and again have the pleasure of seeing

that gentleman, and of deserving the benefit of his support.

Mr. STORER seconded the motion, which was carried unanimously.

Mr. CRISP moved that the thanks of the meeting be given to Mr. J. F. Cole, Mr. Klaftenberger, and Mr. E. D. Johnson, for their services as Vice-Presidents during the past year.

Mr. BLACKIE seconded the motion, which was carried unanimously.

The CHAIRMAN briefly returned thanks.

Mr. E. D. JOHNSON also returned thanks. Although not again a candidate for the suffrages of the members, he assured them that he was only in that position as the result of a very fierce but very friendly encounter between Mr. Cole, Mr. Klaftenberger, and himself as to who should retire and make room for a gentleman who ought to receive some honour from the Institute as a Juror in the Horological Department of the International Exhibition. He (Mr. J.) had also the gratification of expressing to them, in obtaining his own sweet will in that contest for retirement, the pleasure it afforded to him of having thereby an additional opportunity of showing that he could act as he had always maintained that the members of such institutions should do; namely, not to seek for personal honour, but that the horological art should be maintained properly, irrespective of personal aggrandisement altogether. He had received many marks of kindness at their hands; and he could not but judge, especially that considering the number of exhibitors who were members of the British Horological Institute, that to the kind mention of his name was to be attributed the fact that he had been selected by the Royal Commissioners as one of the Jurors to adjudicate on the merits of the works in Class 15. Not only did he feel proud of the honour done him on that particular occasion, but he took that, the only opportunity afforded him, of expressing his great satisfaction at the manner in which the English watchmakers had acquitted themselves at the Exhibition. The honour of having been selected as a Juror he should have looked upon as a comparative disgrace if he had found nothing of British workmanship worthy to be adjudicated upon. He begged to state that in thus withdrawing from high office in the Institute he was perfectly certain of one thing, that whenever his services should be required or that he could do any good, he would venture to say that he would be forthcoming and he felt that whenever he was a candidate for office he should have no difficulty in finding their votes, for when it was found that a man was perfectly disinterested, when as well as working he was ready to put his hand in his pocket in support of an institution, although there might have been heart-burnings, when it came to the push the man who had really deserved well of the watchmakers would receive well from them. He concluded by thanking them for the honour.

Mr. E. D. JOHNSON proposed a vote of thanks to Mr. J. C. Webb for his services as Treasurer during the past year. He (Mr. J.) had little hesitation in saying, that from the manner in which Mr. Webb had transacted the business of the Institute, from his accessibility, and all other good qualities which should characterize a Treasurer, that he might have been again elected, but having moved to a long distance from Clerkenwell he felt that his change of residence was incompatible with a due discharge of the office of Treasurer, and therefore he retired and another gentleman had been elected in his place, Mr. Webb was, however, worthy of a vote of thanks.

Mr. WATSON seconded the motion, which was carried unanimously.

Mr. HENRY WEBB returned thanks on behalf of his brother, who was expected to have been present that evening, to have said farewell to the members of the Institute and the trade.

Mr. H. WEBB proposed a vote of thanks to the Members of the Council. When they took into consideration the great amount of labour that must attach to that body, especially some few who devoted themselves more than the majority, to the furtherance of the interests of the Institute, and which labour had brought it into a flourishing condition and enabled them to overcome obstacles thrown in their way, they certainly were entitled to the warmest thanks of the trade, because they did all that most disinterestedly.

Mr. EVANS seconded the motion, which was put and carried unanimously.

Mr. MARRIOTT proposed a vote of thanks to Messrs. Henry G. Webb and Evans for their services as Auditors during the past year. The accounts required a great deal of attention, which those gentlemen had given to them.

Mr. JACKSON seconded the motion, which was carried unanimously.

Mr. E. D. JOHNSON said that no gentleman connected with the Institute so well deserved thanks at their hands as did its Honorary Secretary, Mr. Hislop, to whom he proposed a vote of thanks most cordially.

Mr. CRISP seconded the motion.

The CHAIRMAN could vouch for the truth of what Mr. Johnson had said. They were very much indebted to Mr. Hislop for the time and labour he had bestowed upon the affairs of the Institute. They all knew that their Honorary Secretary was its mainspring. They hoped that his health would allow him long to continue in his office.

The motion was carried unanimously, and with great applause.

Mr. HISLOP thanked the meeting for that mark of their confidence, at the same time he very much feared that circumstances would prevent him continuing for any length of time in the duties of his office, simply for the reason Mr. Klaftenberger had alluded to, that he found his health was failing and he feared that if he continued his present labours something serious might occur. He was therefore, necessitated to reduce the amount of brain-work that he undertook. He had, they must bear in mind, taken the office only for three months, and now he had filled it twelve. At the same time he felt most keenly that the Institute required for its Honorary Secretary a person who would give himself heartily and earnestly, without any thought of self, to its interests. He hoped that they should be able very soon to find somebody who would be willing to assist in the matter. He had no intention of dissolving his connection with the Institute as long as he lived or it lasted.

He had been a member of it ever since its commencement, and had filled almost every office from that of chairman down to a simple member of council. He, however, found it impossible to continue in his present office. There were many things to attend to. He had had involved accounts to unravel, the Journal to attend to, and numerous other duties so heavy and sometimes so perplexing, that he really did not see how he could continue much longer to perform them. He felt that it would be for the good of the Institute that some other member should take the office from his hands. There were many things which ought to be done which he could not possibly attend to. The affairs of the Institute were by no means in the state of order he should like them to be, although he was warranted in saying that they were in a better position than they had been for some time past. He should like to mention a few facts which did not appear in the report or in the financial statement. Something like an account of assets and liabilities was drawn out last year. On the present occasion, without any request from council or members, he had roughly prepared a statement of certain items, from which he found that at the present moment the Institute owed £110. 14*s.* 4*d*, which was £40 less than the amount they were in debt the last year. To meet that they had cash owing for subscriptions in arrear and those which became due that day together with other amounts £137. 2*s*. 6*d*. In the statement of assets last year various items were put down for furniture, articles in the museum, and other matters, amounting to a large figure, which was not included in the account he had in his hand. He had only reckoned hard cash and good debts. In addition to that, they had Journal stock of the value at cost price of £135 2*s*. 8*d*. Those facts showed that they were in a better position, notwithstanding the depression of trade, than they were in last year. If then, members would support the Institute a little more heartily —if they would bring to it fresh subscribers, help to circulate the Journal, and recommend it as an advertising medium, he had no question but what they would have a large surplus fund to apply to the more special objects of the Institute. One great object they had in view in its formation was to make it the means of encouraging the horological art in every possible way, and one of the best means of doing that was to offer rewards and prizes for work in every shape and form, as well as for articles of design. He thanked them for the kindness they had expressed to him, and he hoped that he should have in greater degree than he heretofore had done, the assistance of the members in endeavouring to carry out its objects. That alone was what they ought to have in mind without reference to any private matters whatever.

Mr. Blackie proposed a vote of thanks to Mr. Gordon for his services in acting as Editor of the Journal during the past year. It was not his (Mr. B's) place to say any thing further to commend the motion for adoption, because the manner in which Mr. Gordon conducted the Journal was sufficient to justify the vote.

Mr. Walsh seconded the motion, which was carried *nem con.*

Mr. Jackson moved a vote of thanks to the Trustees. Although their responsibility was not great, still there was the fear of it before their eyes. It was to be hoped that they would soon have something in trust more than they had had hitherto. He would take that opportunity to acknowledge the vote of thanks passed to the Council.

Mr. Walsh seconded the motion, which was passed unanimously.

Mr. Blackie moved a vote of thanks to the Sub-committees for the services which they had rendered to the Institute during the past year.

Mr. Henry Webb having seconded it, it was carried unanimously.

Mr. Marriott returned thanks on behalf of the members of sub-committees. Their duties were very onerous. It was only by them that an institution of that sort could be thoroughly carried out. Mr. Johnson had said that the accounts needed to be thoroughly investigated, and that everything ought to be put on a fair footing.

Mr. Johnson begged to correct Mr. Marriott. He said that he believed that they had been already thoroughly investigated.

Mr. Marriott. No doubt by the meeting passing a vote of thanks to the Auditors it showed that it thought the accounts had been thoroughly and sufficiently investigated, but he might be allowed to throw out a suggestion that even still more, as Mr. Johnson knew, and had expressed, it was necessary that the business of the Institute should be handled in that efficient manner which alone could be done by sub-committees. Those gentlemen had undertaken the duties, and no doubt would carry them out for the future.

Mr. E. D. Johnson said that there was good service done, and always very generously and fairly by the Press of Clerkenwell. Mr. Farmer the Editor of the Clerkenwell News was there. He was always ready to come among them, and assist them in their objects. He represented them fairly, and often fought their battles when they wanted fighting. He therefore moved a vote of thanks to the Press.

Mr. Watson seconded the motion which was carried unanimously, and was briefly acknowledged by Mr. Farmer.

Mr. Crisp moved a vote of thanks to Mr. Klaftenberger for his conduct in the chair.

Mr. Evans seconded the motion, which was carried unanimously.

The Chairman returned thanks for the honour done him. He should do his best for the Institute, and should come amongst its members as often as he could.

The proceedings then terminated.

MECHANICS.

Fifth Lecture delivered to the British Horological Institute.

By W. Hislop, Esq., F.R.A.S., Hon. Sec.

(*Continued from page 118.*)

Dynamics.—Laws of Motion.

We have this evening to proceed to the consideration of the Second and Third Laws of Motion, having in my last lecture considered the first or "Law of Inertia."

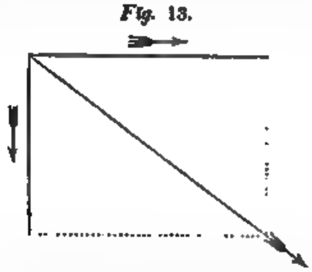
The second law relates to several forces, and is thus stated, "Any change effected in the quiescence or motion of a body is in the direction of the force impressed, and is proportional to it in quantity."

As I have before remarked, we know nothing of forces except by their effects in moving bodies or causing equilibrium or rest. We call those equal forces, however different they may be in their nature, which give to bodies equal momenta or, which is the same thing when the bodies are equal, give to them equal velocities. Therefore, when different forces act upon equal bodies, the forces are proportional to the velocities imparted. The velocity then being proportional to the force,—these two qualities may be represented the one by the other, and hence all that was remarked in our former lecture on the Composition and Resolution of Forces will also be true of the Composition and Resolution of Motion.

We will however for the sake of clearness proceed to demonstrate the law.

First. It is clear without any reasoning whatever that a single force causes motion in a direction similar to its own. There may be two or more forces exerted upon a body. Now if we imagine one of these forces equal to say 4 pounds, and the other equal to 3 pounds, and represent them by proportional lines, as in this diagram (*Fig.* 13) forming

Fig. 13.



two sides of a parallellogram, we shall find that the motion caused by the action of these two forces will be in the direction of the diagonal of this parallellogram.

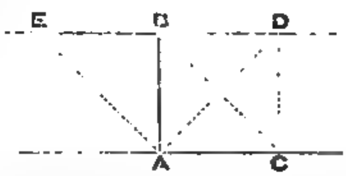
To prove this experimentally, I will take this apparatus: (*fig.* 14) let one side represent a force exerted in one direction as exemplified by pulling the string, let the other side represent another force exemplified by pulling out the frame. I will now cause both these forces to act together, by fastening the end of the string. On pulling out the frame,

Fig. 14.

and thus bringing the force exerted by it and by the string working over the pulley to act together, the ball will move from one corner to a point on the upper side, describing the diagonal of the parallellogram.

Examples of the composition of motion are continually presenting themselves. In fact there is great difficulty in finding a case of simple motion. For instance, if a boat be rowed across a river in which there is a current, it will not move precisely in the direction in which it is impelled by the oars, neither will it move in the direction of the stream, but it will proceed in that intermediate direction which shall be determined by the relative velocities of the forces concerned. Thus, let A (*fig.* 15) be the

Fig. 15.



place of the boat at starting, and suppose the oars are so worked as to impel the boat towards B with a force which would carry it to B in one hour if there were no current in the river. But on the other hand, suppose the rapidity of the current is such, that without any exertion of the rowers, the boat would float down the river in one hour to C. The combined effect of the oars and current will be that the boat will be carried along A D, and will arrive at the opposite shore in one hour at the point D. If the object be therefore to reach the point B, starting from A, the rowers must calculate as nearly as possible the velocity of the current. They must imagine a certain point E, at such a distance above B, that the boat would be floated by the stream from E to B in the time taken in crossing the river in the direction A B if there were no current. If they start with the boat's head towards E, and [illegible]

the boat in the same angle with regard to the shore they will arrive at the point B moving in the direction A B. Thus the boat is impelled by two forces, the oars and the tide. The result is a motion in the diagonal A B.

The action of the wind upon the sails of a vessel and the force thereby transmitted to the keel, modified by the rudder, is a problem which is solved by the principles of the composition and resolution of force. From the number of sails in a full rigged ship, it is obvious that the conditions and limitations are of too complicated a nature to be entered into in a lecture like the present; we will however take one case as an illustration. Let A B (*fig.* 16) be the position of the sail, and let the

Fig. 16.

wind blow in the direction C D. If the line C D be taken to represent the force of the wind, let a parallellogram be constructed of which it is the diagonal. Now by the law of the resolution of forces, this line C D is equivalent to two forces, one in the direction E D of the plane of the canvas and the other perpendicular to the sail. The effect then is the same as if there were two winds, one blowing in the direction F D or against the edge of the sail and the other E D full against its face.

It is evident that the former will produce no effect upon the sail, and the latter will urge the vessel in the direction D G. Let us now consider this force D G as acting in the diagonal of the parallellogram D H G I. It will be equivalent to two forces D H and D I, one of these forces D H is in the direction of the keel, and the other D I at right angles to the length of the vessel so as to urge it sideways. The form of the vessel evidently opposes a great resistance to the latter force and as little as possible to the former. It consequently proceeds with velocity in the direction D H of its keel, and makes way very slowly in the sideward direction which is called "leeway." In the construction of vessels therefore, designed to sail swiftly with the wind on the beam or side of the vessel, it is endeavoured to increase the sidelong resistance, and thus diminish the leeway, while the motion endwise is made as easy and simple as possible.

When the wind is directly opposed to the course it is desired to take there is no position which can be given to the sails which would impel the vessel. In this case the original course is resolved into two directions, in which the vessel sails alternately, a process which is called "tacking." Thus suppose the vessel is required to move from A to E, (*fig.* 17) the wind setting from E to A. The motion A B being resolved into two by being assumed as the diagonal of a parallellogram, the sides A B are successively sailed over, and the vessel by this means arrives at B instead of moving along the diagonal A B. In the same manner she moves along all the various sides, and thus arrives at E. She thus sails continually at a sufficient angle with the wind to obtain an impelling force, yet at a sufficiently small angle to make way towards the desired point.

Fig. 17.

A body falling from the top of a mast while the vessel is in full sail, is likewise an illustration of the resolution of motion. We may perhaps have heard or read some marvellous tales about the swiftness of certain ships, related by individuals of their crews, in which we are told that as a man fell from the mast head the ship passed from under him and he fell into the sea astern. This is simply a falsehood, for however fast a vessel might move, a body falling from the mast would alight at the foot of that mast, just as if the vessel were perfectly still. This is easily proved. The body when connected with the mast moves with the same velocity as the ship, and continues the same motion after it has left the mast, so that both the ship and falling body move with the same speed, and therefore the body falls on the deck at the foot of the mast. It is thus affected by two motions, that occasioned by gravity and that occasioned by the motion of the ship. Hence by the parallellogram of motion the body describes a mean between the two in its descent, moving in the diagonal of the parallellogram.

Thus let the motion endwise in this apparatus, (*fig.* 14) represent the motion of the ship, and the vertical portion represent the height of the mast. If now the ball represent the body in question at the top of the mast, as soon as it begins to fall downwards it is also still urged on by its own momentum and thus moves forward and downward at the same time; the result is, that it comes down to the point directly under it, although that point has moved since it left the mast-head: therefore, describing a slanting path through the air.

The resistance of the air to the falling body will of course somewhat modify results, but in short distances the difference so caused will be practically inappreciable.

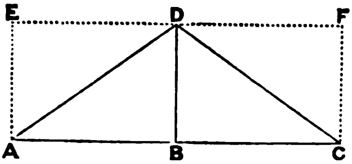
A body let fall from the top of a tower will not fall exactly at the foot, because the top of the tower moves with a greater velocity than the surface of the earth, it being at a greater distance from the centre of motion and therefore describing a larger circle. That the body will fall a little to the eastward has been proved by experiment.

The properties of compound motions are illustra-

ted by some of the equestrian feats exhibited at public spectacles, which are performed with a very different kind of exertion to that generally supposed by the spectators. Horsemen while standing on a horse at full speed, leap over garters and through hoops. The exertion in these cases is not the same as the individual would use if performing the feat from the ground, for in the latter case he would leap from forward as well as upward. When leaping from a horse he only exerts himself so as to rise perpendicularly, while the momentum his body already possesses carries him forward over the obstacle. If he were to leap forward he would alight either on the horse's neck or on the ground before the horse.

To explain this more fully, let A B C (*fig.* 18) be

Fig. 18.



the direction in which the horse moves, A being the point at which the rider quits the saddle, and C the point at which he returns to it; let D be the highest point which is to be cleared in the leap. At A the rider makes a leap towards the point E, and this must be done at such a distance from B, that he would rise from A to E in the time in which the horse moves from A to B. On departing from A the rider has therefore two motions, represented by the lines A E and A B by which he will move from the point A to the opposite angle D of the parallellogram. At D the exertion of the leap being overcome by the weight of his body, he begins to return downward and would fall from D to B in the time in which the horse moves from B to C. But at D he still retains the motion he had in common with the horse, and therefore in leaving the point D he has still two motions, expressed by the lines D F and D B. The compounded effects of these motions carry him from D to C. Strictly speaking, his motion from A to D and from D to C is not in straight lines but in a curve. It is not necessary now to attend to this circumstance as we shall have to speak of these curves when treating of the motion of projectiles.

As further illustrations we may take the ascent of a kite and the motion of the vanes of a windmill. In either of these cases, if the force of the wind be divided into two parts, one of which is supposed to be perpendicular and the other parallel to the side of the body acted on, and construct a proportional parallellogram of which the direction of the wind shall be the diagonal, we shall find that the line perpendicular to the face will be proportional to the force usefully exercised, and subtracted from the original force the remainder will represent the actual loss.

We now proceed to illustrate the Third Law of Motion.

" Re-action is equal and contrary to action."

Like the rest of these laws, and indeed like all absolute truths, we find this applicable both to mind and matter. Set thought unduly in motion in one direction and it will in time return to the opposite. Like the waves of the sea, now heaving above the common level and anon sinking to an equivalent depth, so we find all motion attended with like phenomena; we see, therefore, that all the forces in nature with which we are acquainted, act reciprocally between different masses of matter, so that any two bodies repelling or attracting each other are made to recede or approach with equal momenta. Take now a case of attraction:—suppose this magnet to weigh one pound, and to be opposed to a mass of iron also weighing one pound. It is evident that both the magnet and the iron exert the same pressure upon each other, that is to say, the iron attracts the magnet with the same force that the magnet attracts the iron, and the magnet as efficiently supports the iron, as the iron supports the magnet.

If however one of these bodies be immoveably fixed, and the other be brought near to it, we shall only see motion in the free body. Still the force will be attractive on the stationary body in just the same proportion only that it is opposed in its tendency to motion by the resistance offered by the support to which the magnet is fixed. If now we suppose some force, such as a spring, to be so placed with regard to the magnet and its keeper, that it shall tend to separate them by acting on each, it is evident that the action will be the same in both cases, the iron will be as much pressed outwards as the magnet, and the magnet as much as the iron. I said that if the iron or the magnet be immoveably fixed we shall not observe the motion in it but in the free body. By " immoveably fixing" as it is called, any body, we increase the mass of the body acted on, because we make it a part of a larger system or mass of matter. Thus, if the magnet be fixed to the earth it becomes a portion of its mass, being in fact made one body with it. I explained in my last Lecture that the inertia of a body was in proportion to its mass.

It often happens that when the difference of the magnitude of the bodies considered is very great the motion of the large body may be disregarded. Thus we usually neglect the motion of the sun in treating of the planetary motions produced by his attraction; although by means of very nice observations this motion of the sun becomes sensible. But it is utterly beyond the power of our senses to discover and appreciate the reciprocal motion of the earth, produced by any terrestrial cause, even by the most copious eruption of a volcano, although speaking mathematically we cannot deny that whenever a cannon ball is fired upwards, the whole globe must suffer a minute depression in its course. The boast of Archimedes was therefore accompanied by an unnecessary condition " Give me," said he, " but a firm support and I will move the earth." Granting him his support he could only have displaced the earth insensibly by the properties of his machines. Without any such support, when he threw rocks upon the ships of Marcellus, he actually caused the walls of Syracuse and the island of Sicily to move northwards with as much momentum as carried his projectiles southward against the hostile armaments.

We see therefore that when one body strikes against another body it meets with resistance, this

resistance is equal to the blow struck by the body in motion.

The most remarkable illustrations of this law are observed in elastic bodies. Elasticity as we stated in our introductory lecture is a property by means of which bodies that are compressed return to their former state. Of all bodies those in the form of air or gas are the most eminent for their elasticity. Hard bodies come next in order. If two ivory or metallic balls be struck against each other, the parts at which they touch will be flattened, but no mark is perceptible, their elasticity destroying all trace of it. Soft bodies which easily retain impressions, as clay, wax, putty, &c., have very little elasticity. The elasticity of ivory is very perfect, that is to say it restores itself after compression with a force very nearly equal to that exerted in compressing it; now if two ivory balls of equal weight be suspended each by a line, and one be drawn a little on one side and let go, it will strike against the other ball, and drive it off to a distance nearly equal to that through which the ball first fell. The motion of the first ball is stopped because, when it struck the other, it received in return a blow equal to that it gave, and its motion is consequently destroyed. Therefore when one body strikes against another, the quantity of motion communicated to the second body is lost by the first, but this loss proceeds not from the blow given by the striking body, but from the reaction of the body which it strikes.

If four ivory balls of equal weight be hung in a row, (*fig.* 19) and the first be drawn out of the perpendicular and then let fall against the second it receives a blow in return which destroys its motion. The second ball though it does not appear to move strikes against the third, the reaction of which sets it (the second ball) at rest. The action of the third is destroyed by the reaction of the fourth, which not being reacted upon, flies off to a distance equal to that from which the first ball fell. This effect takes place strictly only with perfectly elastic bodies. If we take two balls of putty, an almost inelastic body, similarly suspended, and one of them be let fall against another, only part of the motion of them will be destroyed, and the two balls will move on to a distance, about half of that from which the first ball fell. Still action and reaction are equal, for the amount of motion gained by the second body is equal to that lost by the first. It becomes a case in which the momentum of one body is shared by a second and equal body, and therefore exhibits only half the effect.

Fig. 19.

Again, if we put both the balls in motion and cause them to descend through equal arcs, they will attain equal velocities, and therefore strike each other with equal forces; after impact they are found to remain quiescent, for action and reaction has been equal in both cases, and therefore the force and motion of each is destroyed. We should observe the same result if the bodies were connected together in any way whatever through any other inelastic body, such for instance as a string. We may take it then as a universal rule, that if one body be set in motion by another body, it must be at the expense of part of the motion of the prime mover. We see here the necessity of constructing the frames of steam engines and all other machinery, so that it shall be as strong and rigid as possible, or else the force of the engine will be employed in shaking and setting its own parts in motion, instead of being usefully exercised upon the desired object.

Before leaving this part of our subject, I wish to allude to a curious calculation in connection with the ivory ball apparatus just shown, which I have met with in Peschel's excellent work on Physics.

If 100 elastic balls were suspended in such a manner that they just touched, their centres being in one horizontal line, and each successive ball containing a mass equal to half that of the preceding, then the velocity of the last ball would equal 238,850,000,000 times that of the first. This velocity would amount to more than 97 millions of miles in a second, supposing the first to move at the rate of one Paris foot; in other words the first ball would describe a space nearly equal to five times the earth's distance from the sun in one second of time. Such an experiment might perhaps appear easy to attempt upon the terms stated, but if the smallest ball have but a diameter of one inch, the largest would have a diameter 20 times greater than that of the earth, and its solid contents would be 8000 times greater.

It is from reaction being contrary to action that reflected motion is produced. If an elastic body in motion strike an elastic plane in a state of rest, the former will recoil with a velocity equal to that with which it advanced. If the impact were perpendicular, it returns in the same direction; but if it were inclined the body returns under the same angle, but in the opposite direction. The angle at which it strikes the plane is called the angle of incidence, and that at which it leaves the plane the angle of reflexion; in perfectly elastic bodies these angles are exactly equal.

Thus when a billiard player strikes the ball perpendicularly against the cushion, it returns in the same direction, but when he sends it obliquely to the cushion it rebounds obliquely to the opposite side, describing an angle the point of which is at the cushion. The more obliquely the ball be struck against the cushion, the more obliquely it rebounds to the opposite side, so that a billiard player can calculate with great accuracy in what direction it will return even so as to strike another ball. This law holds good whatever the nature of the bodies, whether solid, fluid, or gaseous, even although they may be imponderable, such as light or heat.

Illustrations of this Third Law of Motion are to be seen around us on every hand. We sometimes experience them unpleasantly:—if a man walking or running encounters another standing still, he suffers as much from the collision as the man against whom he strikes. When the fist of a pugilist strikes the body of his antagonist, it sustains as great a shock as it gives, but the part being more fitted to endure the blow, the injury and pain are inflicted on his opponent,—this is not the case however when fist meets fist, then the parts in collision are equally sensitive and vulnerable, and the effect is aggravated by both having approached each other with great force. If a leaden bullet be discharged against a plank, it will be found that the round shape of the body is destroyed, and that it has itself suffered a force by the impact, which is equivalent to the effect which it produced on the plank.

Birds in flying strike the air with their wings, and it is the reaction of the air which enables them to rise or advance forwards. The force with which their wings strike the air must equal the weight of their bodies in order that the reaction of the air may be able to support that weight, the bird will then remain stationary.

If the stroke of the wings be more forcible than is required merely to support the bird, the reaction of the air will make it rise, if it be less it will descend; the lark sometimes remains with his wings extended but motionless, in this state it drops rapidly into its nest. A bird expands its wings when it gives the stroke the reaction of which is to impel him onward, and contracts them when moving them back. The swimming of fishes is on the same principle, their fins are expanded and contracted in a like manner; and a man in swimming strikes his hands out to produce the reaction which impels him forward, and turns them edgewise to lessen the effect of the contrary reaction. In rowing, the oars are lifted out of the water after every stroke to prevent any reaction in a backward direction; and even in moving them through the air they are turned edgwise, or feathered, as it is called from its resemblance to the action of the feathers of a bird in flying.

These cases of motion arising from reaction abound. Hero's steam engine, and Barker's mill are instances. Again, in the case of firearms, the gun or pistol recoils or kicks when it is fired. This is because the force exerted by the explosive matter acts upon the firearm as well as upon the ball, but the former having a greater mass than the latter, the motion is (happily) not so evident. If a cannon were firmly fixed to the deck of a ship or the platform of the battery, the discharge would endanger the stability of those structures, but it is placed on a carriage with wheels or rollers and fastened by means of tackle; the discharge throws the gun sufficiently back to enable the muzzle to be reached for the purpose of again loading, the further recoil being prevented by the resistance of the tackle. Still even with these precautions, the firing of a broadside would cause a vessel to roll considerably. In the case of a chase, the firing of the stern guns of the pursued vessel will help it forward, while the discharge of the bow guns of the pursuer always retards his progress. The recoil of cannon has led to the proposal that the conditions of the case should be reversed. That is to say, that the stationary body instead of being a tube, should be a solid cylinder, and the projectile to be in the form of a tube or shell, containing the charge of powder, and placed on the end of this stationary cylinder. One advantage would be increased rapidity in firing, as a number of tubes could be charged beforehand, and then placed on the cylinder and discharged as quickly as they could be replaced. A great disadvantage would be the increased expense.

Such is an imperfect sketch of the Laws of Motion, as developed and arranged by the mighty intellect of Sir Isaac Newton. Every fresh discovery does but add fresh strength to their authority, and confers a new lustre on the memory of that illustrious mind from which they emanated. But Sir Isaac Newton, in common with all great men, lived in advance of his age, he was not comprehended by his contemporaries; he was regarded as a visionary, but he possessed within his own sublime conceptions a full reward for his severest labours.

Let those who have stood with wonder in the midst of that vast universe of knowledge which his discoveries have brought to light, sympathise as they best can with the reverential awe of his great mind when he exclaimed in the consciousness of the unfathomable profound that reigned around him, "I am but as a child playing with a pebble cast up by the waves, while the ocean of truth lies spread out before me."

The comparatively recent discovery of the planet Neptune may be adduced as an instance of the continual confirmation which Newton's theories are receiving. As an illustration of the truth of the laws of motion and gravitation, I may perhaps be permitted to recapitulate briefly the facts of that remarkable discovery.

Anomalies had been apparent in the planet Uranus for some years, so that he appeared to be beyond the influence of gravitation, or else that there must exist some disturbing body of whose existence we knew nothing. Not very long since Mr. Adams of St. John's College, Cambridge, and M. Le Verrier, an eminent French mathematician, concluded independently, from theoretical calculations based upon the indications afforded by the apparent motions of the planet Uranus, that all the anomalies might be accounted for by supposing a disturbing planet to move in an orbit of twice the distance of Uranus from the sun; and subsequently Le Verrier inferred from a most elaborate investigation, that the mass of the disturbing planet was two-and-a-half times that of Uranus—a result that Mr. Adams also arrived at. These mathematicians agreed in fixing the same longitude as the most probable position for the planet. On September 23d of the same year, Dr. Gall of Berlin received a letter from Le Verrier requesting him to search for the hypothetical planet, he having superior advantages for the purpose. On the same evening, Dr. Gall, during a comparison of the heavens with Dr. Bremicker's map, saw a star of the eighth magnitude in the constellation of Aquarius not marked in the map. The motion of this star was so slow that it was necessary to wait till the next night, which con-

tunately was favourable to observation. The star had moved from its place with a motion which agrees fully with Le Verrier's hypothesis, and thus proved to be the sought-for planet. Its diameter cannot be much less than 50,000 miles, it is therefore the largest in our system except Jupiter and Saturn, and its cubical bulk is to that of the earth as 250 to 1. Indications have been observed of a ring and a satellite. It is about 3,200,000,000 miles from the sun, and about 3,100,000,000 mlies from the earth. Its distance from Uranus whose motion it disturbs is 1,400,000,000 miles; its period of revolution is 217 years.

This is one of the most splendid discoveries of modern times, because without any previous observation, the existence of a body unseen before to mortal eyes has been asserted by calculations, derived from the laws of motion and gravitation, and that assertion has proved to be strictly correct.

Take away the laws of motion, and the whole science of astronomy must fall into irrecoverable ruin. Where would Le Verrier's and Adams's discovery have been, had Newton not laid the foundation for it. Great though they may be, they are but satellites revolving around a greater primary. While they receive a high and due meed of honour, let not the mighty minds which have given a complexion and a character to all that have come after them, be forgotten in our ascription of merit, but rather take a still higher place in the esteem and reverence of thinking minds.

THE GRAVITY ESCAPEMENT.

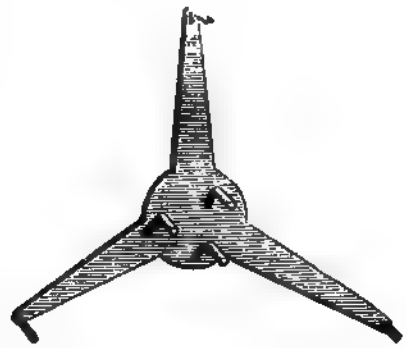
To the Editor of the Horological Journal.

Sir,—The gravity escapement appears to have been a peculiar object of interest to horologists since the days of Cumming; and it is singular that the improvements which have taken place in its construction have been invented by amateurs. Mr. Bloxam was the first to make any great step in advance Mr. Denison advantageously changed the form and arrangement of Mr. Bloxam's, and introduced the valuable addition of a fly. I shall presume in the following observations that your readers are acquainted with Mr. Denison's escapement.

All gravity escapements have hitherto been constructed on the principle that the pin lifts the same pallet on which the tooth drops. In the following escapement, which I call the Pin-Wheel Gravity Escapement, the opposite pallet is lifted to that on which the tooth falls, consequently it is impossible to trip if ten or twenty times the weight be applied.

Fig. 1 is the three-legged wheel, but instead of having a tooth at the end of each leg, as in Mr. Denison's, there is a semi-cylindrical pin with the flat side turned to-

Fig. 1.



wards the centre. Now in Mr. Deniso the pin raises the pallet and the long too immediately drops on the stop of the sa pallet, whereas in my escapement, the in pin lifts the opposite pallet to that on whi the pin of the leg falls.

In *Fig.* 2 the pendulum is advancing the direction of the arrow, propelled by t weight of the pallet A, in contact at G. T pallet B is held up by one of the inner pi

Fig. 2.

C

D

at F, and one of the semi-cylindrical pin the end of the leg is pressing on the sto C, behind the dotted leg as here sho When the pendulum has travelled s

ciently far, the leg pin escapes outside the stop C (not inside, as in Mr. Denison's) the wheel then turns in the direction of the arrow, the pin at E raises the pallet A, at the same instant the pin at F releases the pallet B, which is now in contact with the pendulum at H, and gives the impulse by gravity during the pendulum's return, while the leg pin at I is resting on the stop D. The pallet A is stopped by a banking pin at the moment the pendulum takes up the pallet B. The same action then takes place on the opposite side. The acting surfaces at C and D are struck in a circle from the pivots by which the pallets are suspended, and if intended to go without oil should be jewelled. It can be made with six legs, but I have put three for simplicity of explanation. The inner pins should be set at an angle of 30° in advance of the outer pins.

It should be noticed as a peculiar feature of this escapement that the pendulum does not unlock the wheel, but that the pallet by its own gravity allows it to escape. The impulse is equally divided between the ascent of the pendulum after zero and its descent before it: a principle which Professor Airy has shown to be essential to good time-keeping, and as the pin slides on the dead face of the stop as long or rather longer than in the dead-beat escapement, it indeed appears to me *to combine the principles of Graham's with the Gravity Escapement.*

As far as I am aware, it fulfils all the mathematical requisitions of a good escapement (and if not I shall be only too happy to hear to the contrary), in addition to which I have proved that whatever amount of power be applied, it is totally impossible to trip. I altered one of Mr. Denison's escapements to the Pin-Wheel Gravity Escapement by merely substituting a new wheel and stops. As tripping is impossible, the inner pins may be set at any distance from the centre, and the arc of impulse increased or diminished to any extent. In Mr. Denison's it is one-third of the whole arc. In the Pin-Wheel Gravity Escapement, it is questionable to me if this arc might not be increased with advantage, but this is just the point where Mr. Denison's experience becomes valuable, and as he must naturally feel interested in any escapement that is founded on his own, perhaps he will favour us in your pages with his opinions on the above. I am, Sir, your obedient servant,

R. WEBSTER.

74, Cornhill, June, 9th 1862.

The 6th was the hottest day we have had as yet, this year; from 7 to 10 p.m. there was continuous forked and sheet lightning, chiefly to northwestward, with thunder and rain.

The 9 a.m. wind observations show the direction to have been from N, on 4 days; E, 6; S, 7; W, 12; and calms or very light breezes on 2 days.

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

(*Continued from page* 109.)

1846, April 25.—No. 11,177.

PHILCOX, George.—The invention consists in constructing the chronometer spring in two parts, or in adapting two springs in conjunction, so that as one spring, or one portion of the spring, expands or contracts from the variations of temperature, the other spring or portion of spring equally expands or contracts at the same time and in the same degree, but in an opposite direction.

[Printed 5*d*. See London Journal (*Newton's*), vol. 29 (*conjoined series*), p. 317; and Patent Journal vol. 2, pp. 476, 518, 647, and 675.]

1846, April 28—No. 11,178.

NEWTON, William Edward (*a communication*).—The invention consists in suspending clocks or timepieces by passing a cord or chain round the barrel cylinder or drum. The clock is suspended by the cord, which is fastened in the wall at the top and bottom, so that the weight of the clock acts as the propelling power, instead of the ordinary weights and springs. When the clock requires winding up, it will only be necessary to raise it to its highest point, the reverse motion of the barrel being precisely the same as winding up with a key.

[Printed, 6*d*.]

1846, November 12.—No. 11,443.

YATES, Thomas.—Altering the number of teeth in the escapement wheel and its pinion, and also the wheel in which it acts, so as to make the balance vibrate only once for every half second, instead of four times a second. This may be done by making the escape wheel with twelve teeth instead of fifteen, the pinion below with eight instead of seven, and the wheel into which it acts as usual with forty. The lever thus becomes lengthened and is therefore capable of exerting greater power. By the above improvements the spring is considerably economized and much less friction is produced.

[Printed 5*d*. See Practical Mechanics' Journal, vol. 2, pp. 9, 63, and 233]

EQUATION OF TIME TABLE

For July, 1862.

Day of the Week.	Day of Month	At Apparent Noon. Equation of Time to be *added* to Apparent Time.	Difference for One Hour.	At Mean Noon. Equation of Time to be *subtracted* from Mean Time
		m. s.	s.	m. s.
Tues..	1	3 28·34	0·481	3 28·31
Wed..	2	3 39·88	0·469	3 39·85
Thurs.	3	3 51·14	0·456	3 51·11
Fri ...	4	4 2·09	0·442	4 2·06
Sat ...	5	4 12·69	0·428	4 12·67
Sun...	6	4 22·95	0·413	4 22·92
Mon ..	7	4 32·84	0·396	4 32·80
Tues..	8	4 42·35	0·379	4 42·31
Wed..	9	4 51·44	0·361	4 51·41
Thurs.	10	5 0·11	0·343	5 0·08
Frid..	11	5 8·35	0·325	5 8·31
Sat...	12	5 16·15	0·306	5 16·12
Sun...	13	5 23·50	0·287	5 23·47
Mon ..	14	5 30·39	0·267	5 30·37
Tues..	15	5 36·80	0·247	5 36·78
Wed..	16	5 42·73	0·227	5 42·71
Thurs.	17	5 48·17	0·206	5 48·15
Fri...	18	5 53·11	0·185	5 53·09
Sat....	19	5 57·53	0·163	5 57·51
Sun...	20	6 1·43	0·141	6 1·42
Mon ..	21	6 4·79	0·118	6 4·78
Tues..	22	6 7·61	0·095	6 7·60
Wed..	23	6 9·88	0·071	6 9·88
Thurs.	24	6 11·59	0·047	6 11·59
Fri ...	25	6 12·72	0·023	6 12·72
Sat....	26	6 13·26	0·002	6 13·26
Sun...	27	6 13·21	0·027	6 13·21
Mon ..	28	6 12·56	0·052	6 12·56
Tues..	29	6 11·31	0·078	6 11·32
Wed..	30	6 9·44	0·104	6 9·45
Thurs.	31	6 6·94	0·130	6 6·96

TO OUR READERS.

In consequence of a press of matter, we are compelled to postpone until our next a very interesting article on "The Boiling-Point Thermometer."

TO CORRESPONDENTS, &c.

All Communications for this Journal should be addressed to the Editor, *at the Office*, 35, Northampton Square, Clerkenwell.

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MECHANICS.

Sixth Lecture delivered to the British Horological Institute.

By W. Hislop, Esq., F.R.A.S., Hon. Sec.

(*Continued from page* 132.)

In the course of our study of the Science of Mechanics, it becomes necessary for us to consider the laws which govern and the phenomena which attend, Central Forces.

These forces only obtain in revolving bodies, that is to say, in those bodies in motion, whose path of motion is not in a straight line. We have already alluded to the fact, that force is always exerted in right lines, and also to the fact, that motion will always result in the direction of the force impressed. Now, since a body when once put in motion, unless prevented by obstacles, will persevere in that motion with the same velocity and in the same direction, it follows that a body cannot describe a curved line, unless it is subjected to the action of a constant force or meets with obstacle after obstacle which change at every instant the direction of its motion. If the force which acts on a moving body according to any direction different from that in which it is moving, act at finite intervals of time and communicate at each interval a determinate velocity, the body will describe a polygon. But if the body has received at first a finite velocity and the force which deflects it from its path acts continually or without interruption, the body will then describe a curved line; such for instance is the effect of the constant force of gravity.

Further,—in the motion down an inclined plane, the direction remains unchanged and therefore by its inertia the body retains all the motions impressed upon it continually in the same direction, but when it descends upon a curve, its direction is constantly varying and the resistance of the curve being the deflecting cause, the curve must sustain a pressure equal to that force which would be able thus to deflect a body from the rectilineal path in which its inertia would cause it to move.

From these considerations we can at once observe that rotatory motion, or the motion of a body around a centre must be caused and maintained by two forces, one the force which binds it to the centre of motion and the other a force which gives it a forward motion around that centre. Thus in the case of an ordinary wheel and axle, we have the axis the centre of motion, confining the body to a certain relative position. When I apply power by means of my hand to the edge of the wheel, that power is exercised at a tangent to the circumference and is in fact exerted in a straight line.

It is a fact confirmed by both theory and observation that force always exerts itself in right lines, and as we have before laid down the law, that motion always results in the direction of the force impressed, therefore the motion of the body will always be in a right or straight line. This is universally true, and by no mechanical contrivance whatever can we induce a single force to act in a curved path. If we pass steam through as many convolutions of a tube as we please, still it will always issue from an orifice in any part of those tubes in a straight line. If we whirl a loaded sling as many times as we please, still the stone will when released, fly from that sling in a straight line. It must be evident therefore if such be the natural tendency of force, that any attempt to confine it to a curvilinear path must produce a friction and therefore a loss of motion or power in accordance with the nature of the curve. Thus in circular motion we have much friction, and this is the real reason of the want of success attending the use of rotative steam engines, in which the steam is made to act in a curved path and necessarily one of a large diameter, producing nearly as much friction as though the fly-wheel of an ordinary steam engine had gudgeons or supports of nearly the same diameter as the cylinder or steam box of such rotative engine. It is found therefore practically better to allow the steam its own natural method of expending its force in a straight line and then to transfer that right lined motion to circular motion by mechanism which will allow of the bearings or gudgeons being reduced as small as may be consistent with strength.

If then a body be observed to move in a curvilinear path some efficient cause must exist which prevents it from flying off and compels it to move around a centre. Whatever this cause or force may be it is called the centripetal force being that which connects the body with and imparts a tendency towards the centre. If such body be connected with such centre by a thread, cord, or rod, then such thread, cord, or rod, occupies the place of a force acting upon and retaining a body in its motion and thereby causing it to revolve.

This restraining or centripetal force may also be the attraction of gravitation, such as that exhibited by the superior mass of the sun towards the planets of the solar system. The sun and all the planets are nearly spherical and revolve in elliptical orbits of which the sun forms very nearly one of the foci.

Observations of the motions of the planets justify us in concluding that each planet is attracted to the sun by a force which is directly in proportion to the quantity of matter in the central body, and inversely is proportion to the square of the distance of their centres. We also find that the constituent particles of each body attract each other by a force which varies in like manner. In accordance with what I stated in a former lecture, one body cannot act upon another, without being subject to an equal contrary reaction. Thus the planets and comets being drawn towards the sun,

likewise attract the sun towards them by the same law. Thus also the satellites are attracted towards the planets, and the planets contrarily towards the satellites, and both these again towards the sun.

This attractive property is therefore common to the sun, planets, their satellites, and to comets, and in fact we may regard the mutual gravitation of the celestial bodies as a property generally obtaining throughout the universe.

We see from these examples that rotative motion being caused by two forces, those forces must have a certain reciprocal action. That is to say, the centripetal force or that which tends towards the centre, has a certain amount of action on the centrifugal force or that which tends from the centre.

The latter is in fact the same force as that which is at first impressed in giving motion to the rotating body. A pressure *outwards* is thus produced evincing a tendency of the moving body to fly off from the centre of motion—and the amount of this pressure entirely depends on the curvature of the path in which the body is constrained to move, and on its inertia and is therefore altogether independent of the weight and would in fact exist if the weight were without effect. It increases as the radius of curvature increases, but it has also a dependance on the velocity with which the moving body swings round the centre of curvature. This velocity is estimated either by the actual space through which the body moves or by the angular velocity of a line drawn from the centre of the circle to the moving body. That body carries one end of this line with it while the other remains fixed to the centre. *See Fig.* 20. This line is

Fig. 20.

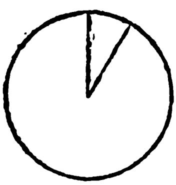
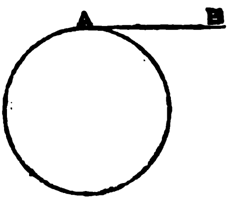


Fig. 21.



called the Radius Vector. As this angular swing around the centre increases, the centrifugal pressure increases and increases as the square of this angular velocity.

The centrifugal force of a body is everywhere equal to that which it would acquire in falling by means of the same force (if uniform) through half the radius or one-quarter of the diameter. We may thus easily calculate the velocity with which a sling of given length must revolve, in order to retain a stone in all positions. Supposing the motion to be in a vertical plane, it is obvious that the stone will have a tendency to fall when it is at the uppermost point of the orbit unless the centrifugal force be at least equal to the force of gravity.

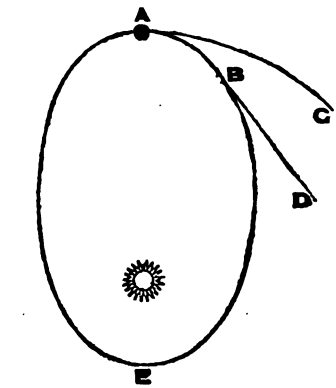
Thus if the length of the sling be two feet, we must find the velocity acquired by a falling body through a height of one foot, which will be eight feet in a second and therefore this must be its velocity at the highest point and with such velocity it would perform each revolution in about a second and a half, but its motion at other parts of its orbit will be greatly modified by the gravitation of the stone.

This pressure will if the opposing force be removed cause the body to fly off at the tangent to the circle described, not in a line from the centre but at a tangent to the circle.

Thus if a stone whirled round in a sling gets loose at A, it flies off in the direction A B (*fig.* 21) It is the property of a line tangent to a circle that it should form a right angle to a line drawn from the point of the circumference where it touches, to the centre of the circle. This projectile force then would be more properly called the tangential than the centrifugal force. But motion in the direction of the tangent would remove the body further from the centre, a tendency therefore to such motion is a tendency to leave the centre and that part of its force which tends to produce motion thus away from the centre is called the centrifugal force.

A simple method of illustrating the combined effects of centrifugal and projectile or tangential forces, is exemplified in this diagram of the orbit of the earth (See *fig.* 22) If these two forces

Fig. 22.



which produce this circular motion were not accurately adjusted to each other one would alternately prevail over the other, and we should either approach so near the sun as to be burnt or recede so far from it as to be frozen. I have described the earth as moving in a circle, to make the illustration more simple, but in reality these two forces are not so proportioned as to produce circular motion; the earth's path or orbit is not circular but eliptical or oval. In order to explain the action of the law in this case, let us suppose that when the earth is at A, its projectile force does not not give it a velocity sufficient to counter balance that of gravity so as to enable these powers conjointly to carry it round the sun in a circle. The earth will then instead of describing A C approach nearer the sun in the dic tion A B. What then now is to prevent us from falling nearer the sun, seeing that its attraction increases as we advance towards it. At the point B also, the projectile force is no longer at right angles with the force of gravity, but inclines more nearly to it, therefore the force of projection acting in the line B D will combine with the force of gravity to bring the earth nearer the sun, so

that by being drawn by one power and driven by another, it would seem impossible for us to escape destruction. But nature abounds in resources. The earth continues to approach the sun with an accelerated motion till it reaches the point E when the projectile force once more acts at right angles to the force of gravitation. The centrifugal force has however increased with the accelerated motion of the body, it has therefore now in its turn a preponderance over the force of gravitation, consequently the earth flies further from the sun till its diminished motion again enables the attractive force to overpower it when it again returns in the same path.

Upon the principles attached to the consideration of centrifugal force the whirling machine is constructed. (See *Fig.* 11 *ante*) We are thus enabled to place any known weights at given distances from centres around which they are whirled, either with the same angular velocity or with velocities having a certain proportion. In the particular contrivance attached to the machine and shown in *fig* 23 threads

Fig. 23.

attached to the whirling weights are carried to the centre around which they revolve and these passing over pullies are connected with a scale bearing weights which may be varied at pleasure. When the whirling weights fly from their respective centres by reason of the centrifugal force they draw up the weights attached to the other end of the threads and the amount of the centrifugal force is estimated by the weight which it is capable of raising.

We will now proceed to demonstrate by experiments on this machine the various statements which we have made.

1st. We will prove that centrifugal force is equal in equal bodies revolving at equal speeds and at equal distances from the centre. These two balls are equal and being connected by a string are placed at equal distances from the centre of motion (See *fig*. 12). When caused to revolve they remain in their respective positions.

2nd. If one of these balls is placed at a greater distance, from the centre than the other, its centrifugal force preponderates in proportion to the difference of the radius of motion and it therefore flies off from the centre drawing the other ball with it.

3rd. We now take unequal balls, and if these are placed at equal distances from the centre, the heavier ball preponderates in its centrifugal force over the lighter ball and draws it to its own side of the frame.

4th. If however we place the balls at distances in proportion to their respective weights, we shall find that they will balance each other, thus proving that centrifugal force is in proportion to the weight and velocity of a body.

5th. This may likewise be shown by a hemisphere having attached to it a small ball by means of a wire;—when the smaller body has velocity and momentum, it draws the larger body away from the centre, but when placed in a position proportionate to the respective masses, the system remains in equilibrium. This is shown by affixing a flat disc to one of the revolving centres and placing the hemisphere with its attached ball upon it.

The amount of force thus exerted may be proved by these two pieces of apparatus;—(See *fig*. 23) which represents one frame or tower.

6th. In accordance with the conditions of the first experiment proving that equal bodies revolving with equal speed at equal distances from the centre have equal centrifugal force, I now place equal weights at equal distances from the centre, and also observe that equal weights are placed in the scales within the towers. Centrifugal force being thus equal, the weights will rise at the same instant of time.

7th. I now take unequal weights, one being twice as heavy as the other, and I place the heavier weight one half nearer the centre in one frame than the other, its velocity will thus be only half that of the other weight because it revolves in a circle only half the diameter of the former. We shall now find that the weights are still raised at the same moment thus proving that the centrifugal force is in direct proportion to the quantity of matter multiplied into the velocity or into the distance from the centre.

8th. If now I place the unequal weights at equal distances, the centrifugal force of the heavier ball will be increased in proportion to its weight, that is, it will be double that of the smaller one, so that to cause both to strike at the same instant, I must double the weight in the tower.

9th. If bodies of equal weight revolve in equal circles at unequal velocities the centrifugal forces are as the squares of the velocities. To prove this I again equalize the weights in the frames (one being attached to each revolving centre), but I place four times the weight in one of the towers

The spindle of this frame has a pulley on its axis, as nearly half the diameter of the other pulley as possible. If the band is placed upon this pulley, it will revolve with twice the speed of the other, and the weight will still rise at the same instant of time, proving that a double velocity will exactly counterbalance a quadruple power of attraction to the centre of the circle.

Familiar illustrations of the effects of centrifugal force abound; such for instance is the use of the sling to which I have already alluded, in which the stone when whirled round by the hand in a direction perpendicular to the ground does not fall out of the sling even when it is at the top of its circuit, and consequently has no support beneath it. The centrifugal force acting from the hand which is the centre of motion is greater than the weight of the body and therefore prevents its fall.

In like manner a glass of water may be whirled so rapidly that even when the mouth of the glass is downwards, the water will still be retained in it by the certifugal force. Again if a vessel of water be whirled round its own axis, the water will be

observed to rise on its sides and sink in the centre. This effect might be carried so far as to cause the water to flow over and leave the vessel empty. In the case likewise of a hoop, when at rest and placed on its edge, it would very quickly fall to the ground but when it is moving forwards, a slight inclination towards either side, causes the parts to acquire a motion towards that side, those which are uppermost being most affected by it and this lateral motion assisted by the curvature of the surface of the hoop causes its path to deviate from a rectilinear direction, so that instead of moving straight forwards, it turns to that side towards which it begins to incline and in this position its tendency to fall still further is counteracted by the centrifugal force, and thus it generally makes several complete revolutions before it falls.

In a corn mill the grain being admitted between the stones through an opening in the centre of the upper one is then kept turning round between them and is by its centrifugal force always tending and travelling outwards until it escapes as flour from the circumference. It is stated by Dr. Arnott that if a man lay down on a mill stone, with his head near the edge, he will fall asleep and die of apoplexy from the pressure of blood on the vessels of the brain. A mop or broom made to turn quickly on its axis, throws the water off in all directions and quickly dries itself. Sheep in wet weather thus discharge the water from their fleeces, by a semi-rotatory shake of the skin; water dogs likewise on coming to land dry themselves by the same action.

This principle is made use of in a machine known as Robinson's drying machine; blankets, cloths or other objects requiring to be dried, are placed in a circular box, the outer edge of which is perforated with holes. This is then put in rapid motion by means of a multiplying wheel and handle, the consequence is that the moisture flies off through the holes, leaving the fabric comparatively dry.

Water poured obliquely into a funnel, runs round the interior of it and often leaves an open space of air all the way down through it, owing principally to the centrifugal force. Whirlpools and eddies occur whenever a current is compelled suddenly to bend its course, the water by tending to continue its straight motion is heaped up on the outer edge of the vortex and thus leaves a pit surrounded by a liquid revolving ridge Charybdis in the Meditereanean and Maelstrom off the Norwegian coast are famous examples. Carriages are often overturned in rounding corners. The inertia causes the body of the vehicle to persevere in its former course, while the front wheels are taking a new direction.

Thus a loaded stage coach running south and turning suddenly east or west, strews its passengers on the south side of the road. An animal causes its weight to resist this force by voluntarily inclining its weight towards the corner, and as the centrifugal force increases with the velocity, therefore a greater inclination of the body is necessary to resist it. In skating with great velocity, this leaning inwards at the turnings becomes very remarkable, and gives occasion to the fine variety of attitudes displayed by the expert; thus if a skater finds his body inclined to one side and in danger of falling he merely causes the skate to describe a curve towards that side, and the tendency of his body to move straight on, or in other words its centrifugal force restores the perpendicularity.

This tendency of bodies to fly off from the centre forms the acting principle in that beautiful application of theory to practice, the steam governor of the celebrated Watt. If a pair of common fire tongs be suspended by a cord and be made to turn by the twisting or untwisting of the cord, the legs will separate from each other with a force proportioned to the speed of rotation, and will again collapse when the rotation ceases. The steam engine governor may be familiarly described as a pair of tongs with heavy balls at the end of each leg.

When I put this model of the steam governor in rotation it can be seen that the balls fly off from the centre and the amount of their distance from the centre depends on the speed with which they are made to revolve. A moveable collar slides on the axis of the governor, which is connected by rods to the arms to which the balls are fastened so that when the balls fly out the collar rises and again falls down when the balls are depressed. A forked lever takes into a groove turned in this collar, so that it can neither rise nor fall without elevating or depressing the lever, this lever is in connection with what is called a throttle valve, which when closed completely prevents the passage of the steam from the boiler to the cylinder, and when open affords but little obstruction to such passage, so that the quantity of steam allowed to pass depends on the angle to which the valve may be opened. If then the speed of the engine be increased either from some portion of the machinery being thrown out of gear or the obstruction to motion diminishing, the balls fly further out, the centrifugal force being increased, and consequently the lever is elevated and the valve proportionately closed, admitting less steam and diminishing the speed.

This property also causes bodies of a soft yielding or fluid nature to alter their form when caused to rotate rapidly. If for instance a ball of clay were made to rotate rapidly on the axis of the machine, it would become altered in its form. Thus this system of steel hoops, assumes a flattened shape in the direction of its diameter or axis when caused to revolve, because the parts which lie at the greatest distance from the centre of motion have the greatest tendency to fly off. This change of form is what has actually happened to our earth. It has been ascertained by experiment, that the figure of the earth deviates from a perfect sphere in about the 300th part of its diameter or in fact that it has bulged out 17 miles at the equator. As might be supposed the same cause operates more powerfully on other planets which revolve more rapidly on their axis. The forms of Jupiter and Saturn are much more oblate, and it has been calculated that if the rotation of our earth were increased seventeen times faster than it is, the bodies or matter at the equator would have centrifugal force equal to their gravity, and a little more velocity would cause them to fly off altogether or to rise and form a ring round the earth, like that which

surrounds Saturn. It is thought probable by many that this ring of Saturn's has been formed in this way, and is now supported chiefly by the centrifugal force of its parts. Were it to crumble to pieces, those pieces might still revolve as so many little satellites. The true satellites of Saturn are only more distant masses sustained in the same manner. Our earth and the other primary planets, have the same relation to the sun that these satellites have to Saturn; all being sustained by this admirable balance between centrifugal force and gravity.

It is also far from improbable that there are many masses of matter in space which are so small as to be invisible to our eyes at the distances at which they move. Indeed it is thought that meteoric stones are merely bodies thus revolving in their own orbits and in process of time intersecting the earth's orbit and thus becoming entangled by its atmosphere, are brought within the influence of its gravitation and descend upon its surface with tremendous force.

The nebular theories of the elder Herschel and of Laplace receive a very material assistance from this centrifugal force. By these theories matter is supposed first to exist as a vapour or in a nebulous form, such as that presented by some comets; a motion of rotation being given to this mass of matter, modifications take place such as those we observe in the planets.

Professor Plateau of Ghent has arranged an experiment by which this theory of formation is illustrated. Proceeding upon the assumption that if it were possible to isolate a mass of plastic matter from the influence of gravitation and give it a rotatory motion around some fixed axis it would present the various phenomena of figure seen in the planets, he suggested the following means for carrying out his idea.

If a mixture of alcohol and water be made of precisely the same specific gravity as olive oil, and a small quantity of the latter be dropped into the mixture it will be found to arrange itself in the form of a perfect sphere. This sphere being isolated from the effects of gravitation through being suspended in a liquid of the same specific gravity can be placed in any position within it. In this condition the mass of oil illustrates the mutual attraction existing between the particles of a body. Being free to move can thus they arrange themselves in accordance with this attraction in that form in which they can approach to each other in the closest degree. Thus presenting the exquisitely true and beautiful form which you have before you. If now a motion of rotation be given to this spherical mass a number of curious phenomena will be noticed. To exhibit them more readily I have prepared an apparatus for the purpose consisting of a glass globe containing alcohol mixed with water into which a small quantity of oil coloured red has been introduced. The mass now floats suspended midway in the globe in the form of a perfect sphere. The box behind the globe contains a piece of clock-work which causes a vertical wire suspended in the centre of the globe to rotate with a graduated speed at will. The wire being carefully placed in the centre of the sphere of oil is made to revolve thus turning round the sphere with a gradually increasing speed. If we now watch the sphere we shall find that it loses its perfect form and becomes flattened at the poles and bulges out at the equator. As we increase the speed this flattening increases and goes on until the mass has become thicker towards the outside than in the centre. A further increase of speed causes it to divide from the axis, *presenting a detached ring* like the ring of Saturn. Presently this ring will break into two or more masses, often of various sizes, which individually assume the spherical form and rotate around an axis of their own with an orbit of motion round the central axis; exhibiting an extraordinary resemblance to the bodies of the solar system. Unfortunately here our mechanical appliances fail in continuing this interesting movement for any length of time, or further interesting facts might be observed illustrating still more forcibly the laws of motion.

As it is however we may observe the variations of the planes of the orbits of the rotating bodies with regard to each other, together with the elliptical path traced by each varying from a close approach to the circle to a curve of very considerable excentricity. With many other phenomena which we will not stay at present to particularize.

In these illustrations we have seen and in our next lecture on the laws of gravitation, we shall still further observe the remarkable universality of dynamical laws, so that the dew drop and the grain of sand are held together, and governed in their motion by the same forces that bind together the vast orbs that whirl through space, and that control these masses into a symmetry and precision of motion, that prevents their interference with each other, and enables each to fulfil its desired course. Vast though the distance and immense though may be the masses still we are able by observation of the common phenomena around us to understand their action and even "to throw the plumb line into space," gauge, measure, and comprehendtheir phenomena.

Scientific attainment or the attainment of physical knowledge, is therefore one of the greatest and most glorious attributes of mind. Let us make what discovery we may, let us pierce deeper and deeper into space, let our minds understand more and more of the vast shoreless ocean of knowledge, still there remains an object of wonder, above the mightiest works of Creation, still mightier and more wondrous, even that intelligence which is capable of understanding and appreciating so much as it may have attained concerning universal truth

The rightly balanced mind when exercised on such vast themes, has in itself a subject of still greater wonder and astonishment. Physically considered, man in his greatest beauty and power, is the merest atom, the veriest mite, when compared only with the orb which he inhabits, but the marvel is that so minute a speck should contain so mighty an agent. In giving therefore full rein to our desire of knowledge, we are but fulfilling our highest destinies and acting as those should act who possess the mightiest and most mysterious of these works of Infinity.

THE BOILING-POINT THERMOMETER.

Bearing in mind our promise to offer occasional papers on philosophical instruments—explanatory of their scientific principles of action, mode of construction, and practical application,—we now enter upon the consideration of the Boiling-Point Thermometer, sometimes called the mountain thermometer, from its application to the measurement of heights.

In the first place, let us consider the scientific principles of the instrument.

The temperature at which a fluid *boils* is called the boiling-point of that particular fluid. It is different for different liquids; and, moreover, in the same liquid it varies with certain changes of circumstance. Thus the same liquid in various states of purity would have its boiling temperature altered in a slight degree. There is also an intimate connection with the pressure under which a fluid is boiled, and its temperature of ebullition. Liquids boiled in the open air are subjected to the atmospheric pressure, which is well known to vary at different times and places, and the boiling-point of the liquid exhibits corresponding changes. When the pressure is increased on the surface of any fluid, the temperature of ebullition rises; and with a decrease of pressure, the boiling goes on at a lower degree of heat.

In the case of water, we commonly state the boiling-point to be 212°F.; but it is only so at the level of the sea, under the mean pressure of the atmosphere, represented by a column of 29·92 inches of mercury at a temperature of 32° F, and when the water is fresh and does not contain any matter chemically dissolved in it. When steam is generated and confined in a boiler, the pressure upon the boiling water may be twice or thrice that of the atmosphere. Experimentally it has been found, that if the pressure in the boiler be 25lbs. on the square inch, the temperature of the boiling water, and of the steam likewise, is raised to 241°; and under the exhausted receiver of an air-pump, water will boil at 185°, when the pressure is reduced to 17 inches of mercury.

Now as the atmospheric pressure is diminished by ascent, as shown by the fall of mercury in the barometer, it follows that in elevated localities water, or any other fluid, heated in the open air, will boil at a temperature lower than at the sea level. Therefore, there must be some relation between the height of a hill, or mountain, and the temperature at which a fluid will boil at that height. Hence the thermometer, as used to determine the boiling-point of fluids, is also an indicator of the atmospheric pressure; and may be used as a substitute for the barometer in measuring elevations.

If the atmospheric pressure were constant at the sea level, and always the same for definite heights; we might expect the boiling-points of fluids also to be in exact accordance with height; and the relation once ascertained we could readily, by means of the thermometer and boiling water, determine an unknown height, or for a known elevation assert the boiling temperature of a liquid. However, as the atmospheric pressure is perpetually varying at the same place, within certain limits, so there are, as it were, sympathetic changes in the boiling temperatures of fluids. It follows from this, that heights can never be accurately measured either by the barometer or the boiling-point thermometer, by simply observing at the places whose elevations are required. To determine a height with any approach to accuracy, it is necessary that a similar observation should be made at the same time, at a lower station, not very remote laterally from the upper, and that they should be many times repeated. When such observations have been very carefully conducted, the height of the upper station above the lower may be ascertained with great precision, as has been repeatedly verified by subsequent trigonometrical measurement of elevations so determined. If the lower station be at the sea level, of course the absolute height of the upper is at once obtained.

We have now to examine the construction of the boiling-point thermometer and its necessary appendages.

Of the various arrangements of the apparatus which have come under the writer's notice, that of Messrs. Negretti & Zambra appears to him the best.

The thermometer is made with an elongated bulb so as to be as sensitive as possible. The scale, about a foot long, is graduated on the stem, and ranges from 180° to 214°, each degree being

sufficiently large to show the divisions of tenths of degrees. A sliding metallic vernier might perhaps with advantage be attached to the stem; which would enable the observer to mark hundredths of a degree. The boiler is so contrived as to allow not only the bulb but the stem also of the thermometer to be surrounded by the steam. The arrangement is readily understood by reference to the accompanying diagram.

C, is a copper boiler, supported by a tripod stand so as to allow a spirit lamp A, made of metal, to be placed underneath. The flame from the lamp may be surrounded by a fine wire gauze, B, which will prevent it being extinguished when experimenting in the external air. EEE, is a three-drawn telescope tube, proceeding from the boiler, and open also at top. Another tube, similarly constructed, envelopes this, as shown by DDD. This tube is screwed to the top of the boiler and has two openings, one at the top to admit the thermometer, the other low down, G, to give vent to the steam. As the steam is generated it rises in the inner tube, passes down between the tubes, and flows away at G. The thermometer, is passed down, supported by an india-rubber washer, fitting steam tight, so as to leave the top of the mercury, when the boiling point is attained, sufficiently visible to make the observation. The telescopic movement, and the mode of supporting the thermometer, enable the observer always to keep the bulb near the water, and the double tube gives all the protection required to obtain a steady boiling-point. Some boiling-point thermometers are constructed with their scales altogether exposed to the air, which may be very cold, and consequently may contract to some extent the thread of mercury outside the boiler. The steam having the same temperature as the boiling water, keeps the tube, throughout nearly its whole length, at the same degree of heat, in the apparatus described. The whole can be packed in a tin case, very compactly and securely for travelling.

When the apparatus is required for practical use, sufficient water must be poured into the boiler to fill it about one-third, through an opening, F, which must be afterwards closed by the screw plug. Then apply the lighted lamp. In a short time steam will issue from G, and the mercury in the thermometer, kept carefully immersed, will rise rapidly until it attains a stationary point, which is the boiling temperature. The observation should now be taken and recorded with as much accuracy as possible, and the temperature of the external air must be noted at the same time by an ordinary thermometer.

Those who possess a boiling-point thermometer should satisfy themselves that it has been correctly graduated. To do this it is advisable to verify it with the reading of a standard barometer reduced to 32°F. The tables of "Vapor Tension" will furnish the means of comparison. Thus if the reduced reading of the barometer be 29·922, the thermometer should show 212° as the boiling-point of water at the same time and place; if 29·745, the thermometer should read 211·7; and so on as per table. In this way the error of the chief point of the scale can be obtained. Other parts of the scale may be checked with a standard thermometer, by subjecting both to the same temperature and comparing their indications. The graduations as fixed by the makers are not always to be trusted; and this essential test should be conducted with the utmost nicety and care.

Admiral Fitz Roy writes, in his "NOTES ON METEROLOGY:"—

"Each degree of the boiling-point thermometer is equivalent to about 550 *feet of ascent*, or one-tenth to 55 feet; therefore, the smallest error in the graduation of the thermometer itself will affect the height deduced materially.

"In the thermometer which is graduated from 212° (the boiling-point) to 180°, similarly to those intended for the purpose of measuring heights, there must have been a starting point, or zero, from which to begin the graduation. I have asked an optician in London how he fixed that zero, the boiling-point; 'By boiling water at my house,' he replied. 'Where is your house?' In such a part of the town, he answered. I said. 'What height is it above the sea?' to which he replied, 'I do not know;' and when I asked the state of the barometer when he boiled the water, whether the mercury was high or low he said that, he had not looked at it! Now, as this instrument is intended to measure heights and to decide differences of some hundred, if not thousand feet upwards, at least one should endeavour to ascertain a reliable starting point. From inquiries made, I believe that the determination of the boiling-point of ordinary thermometers has been very vague, not only from the extreme difficulties of the process itself (which are well known to opticians), but from the radical errors of not allowing for the pressure of the atmosphere at the time of graduation---which may be much, even an inch higher or lower than the mean, or any *given height*—while the elevation of the place above the level of the sea is also unnoticed. Then there is another source of error, a minor one perhaps: the

inner limit, the 180° point, is fixed only by comparison with another thermometer; it may be right or it may be very much out, as may be the intermediate divisions, for the difficulty of ascertaining degree by degree is great; and it must be remembered that the measurement of a very high mountain depends upon those inner degrees from 200° down to 180°, thereabouts. Hence the difficulty of making a reliable observation by boiling water, seems to be greater than has been generally admitted."

The water employed should be pure. Distilled water would therefore be the best. Under the circumstances at which fresh water boils at 212°, sea water boils at 213°·2, The boiling temperature is raised by the chemical solution of any substance in the water, and the more with the increase of matter dissolved.

From a knowledge of this principle, marine engineers make use of the thermometer to determine the amount of salts held in solution by the water in the boilers of sea-going steamers. Common sea water contains $\frac{1}{33}$ of its volume of salt and other earthy matters. As evaporation proceeds the solution becomes proportionally stronger, and more heat is required to produce steam. The following table from the work of Messrs. Main and Brown on the Marine Steam Engine, shows the relation between the boiling-point under the mean pressure of the atmosphere, or 30 inches of mercury, and the proportion of matter dissolved in the water.

Proportion of Salt in 100 parts of water	0	Boiling-point	212°
"	$\frac{1}{33}$	"	213·2
"	$\frac{2}{33}$	"	214·4
"	$\frac{3}{33}$	"	215·5
"	$\frac{4}{33}$	"	216·6
"	$\frac{5}{33}$	"	217·9
"	$\frac{6}{33}$	"	219·0
"	$\frac{7}{33}$	"	220·2
"	$\frac{8}{33}$	"	221·4
"	$\frac{9}{33}$	"	222·5
"	$\frac{10}{33}$	"	223·7
"	$\frac{11}{33}$	"	224·9
"	$\frac{12}{33}$	"	226·0

When the salts in solution amount to $\frac{12}{33}$ the water is saturated. It has also been ascertained that, when a solution of $\frac{4}{33}$ is attained, incrustation of the substances commences on the boiler. Hence it is a rule with engineers to expel some of the boiling water, when the thermometer indicates a temperature of 216°, and introduce some more cold water, in order to prevent incrustation which not only injures the boiler but opposes the passage of heat to the water. The thermometer used for this purpose should be very accurately graduated, and the scale must be considerably higher than, though it need not read so low as, that of the mountain thermometer.

If a substance is held mechanically suspended in water, it will not affect the boiling point. Thus, muddy water would serve equally as well as distilled water. However, as it cannot be readily ascertained that nothing is dissolved chemically when water is dirty, we are only correct when we employ pure water.

Having considered how to make observations with the proper care and accuracy, it becomes necessary to know how to deduce the height by calculation. That a constant intimate relation exists between the boiling temperature of water and the pressure of the air, we have already learned. *All* this knowledge is the result of elaborate experiments made by several scientific experimentalists, who have likewise constructed formulæ and tables for the conversion of the boiling temperatures into the corresponding pressures of vapour, or, which is equivalent, of the atmosphere, when the operation is performed in the open air. As might be expected, there is not a perfect accord in the results arrived at by different persons. Regnault is the most recent, and his experiments are considered the most reliable. An elaborate Table of Aqueous Vapour Tension and Temperature, founded on *Regnault's* researches, is given by Sir. H. James in his "Instructions for Taking Meteorological Observations." Tredgold, in his work on the Steam Engine, gives a simple formula for converting the temperature into the corresponding pressure; but the results do not accord very closely with Regnault's, or others. If b, be the height of the barometer at 32° F., and t, the boiling temperature of water, Tredgold's formula is,

$$b = \left(\frac{t+100}{177}\right)^6$$

From the above formula, or from a table of vapour tension, such as that given by Sir H. James, we can obtain the pressure in inches of mercury at 32°, which corresponds to the observed boiling point; or *vice versâ*, if required. From the pressure the height may be deduced by the method for finding heights by means of the barometer.

The following table expresses very nearly the elevation in feet corresponding to a fall of 1° in the temperature of boiling water:

Boiling Temperatures between.	Elevation in feet for each Degree.
214° and 210°—	520
210 and 200—	530
200 and 190	550
190 and 180	570

These numbers agree very well with the results of theory and actual observation.

The assumption is that the boiling-point will be diminished 1° for each 520 feet of ascent until the temperature becomes 210°, then 530 feet of elevation will lower it one degree until the water boils at 200°, and so on; the air being at 32°.

Let H represent the vertical height in feet betweens two stations; B and b, the boiling points of water at the lower and upper stations respectively; f, the factor found in the above table. Then

$$H = f\,(B-b)$$

Further, let M be the mean temperature of the stratum of air between the stations. Now if the mean temperature is less than 32° the column of air will be shorter; and if greater, longer than at 32°. According to Regnault, air expands $\frac{1}{491\cdot13}$ or ·002036, for each degree increase of heat. Calling the correction due to the mean temperature of air, C, its value will be found from the equation,

$$C = H\,(m-32)\ \cdot002036.$$

Calling the corrected height H′, it will be found from the formula,

$$H' = H + H\,(m-32)\ \cdot002036$$

that is, $H'=H\left\{1 + (m-32)\ \cdot002036\right\}$

and substituting the value of H

$$H' = f\,(B-b)\left\{1 + (m-32)\ \cdot002036\right\}$$

Strictly, according to theoretical considerations, there is a correction due to latitude, as in the determination of heights by the barometer; but its value is so small that it is practically of no importance.

If a barometer be observed at one of the stations, the table of vapour tensions will be useful in converting the pressure into the corresponding boiling-point, or *vice versâ*; so that the difference of height may be found either by the methods employed for the boiling-point thermometer or the barometer.

In conclusion, it may be remarked that observers who have good instruments at considerable elevations, as sites on mountains or plateaus, would confer a benefit to science by registering for a length of time, the barometer along with the boiling temperature of water, as accurately as possible. Such observations would serve to verify the accuracy of theoretical deductions, and fix with certainty the theoretical scale with the barometer indications.

The following Table, will serve to show the agreement between the observed mean barometer and the theoretical barometer, corresponding to the observed mean boiling-point at the place.

Examples, *in calculating Heights from the Observations of the Boiling-Point of Water.*

1. At Geneva the observed boiling-point of water was 209°·335; on the Great St. Bernard it was 197°·64; the mean temperature of the intermediate air was 63°·5; required the height of the Great St. Bernard above Geneva.

Method (*a*), by formula,

$$H' = f\,(B-b)\left\{1 + (m-32^\circ)\ \cdot002036\right\}$$

In this case f is between 530 and 550, or 540.

B =	209·335	m =	63·5
b =	197·64		32
	11·695		31·5
f =	540		·002036
	6315·3		0·0641340
	1·064		1
H′ =	6719·5 feet		1·064

Method (*b*), by Princep's Tables, given in the "Asiatic Journal," No. 16, for April 1833.

209°·335	gives	1362	in Table I.
197·64	„	7518	„
		6156	
63·5	„	1·065	in Table II.
Height		6556·140	

Method (*c*), by Tables supplied with Boiling-Point Apparatus made by Messrs. Negretti & Zambra.

209·335	gives	1464	in Table I.
197·64	„	7736	„
		6272	
63·5	„	1·07	in Table II.
Height		6711	

Method (*d*), by Tables in G. H. Simmonds' "Meteorological Tables."*

209·335	gives	2444	in Table XI.
197·64	„	8753	„
		6309	
63·5×2	„	1·07	in Table XII.
Height		6750·6	

Method (*e*), by converting the boiling points into the corresponding pressures, by Sir H. Jame's Table of Vapour Tensions, and hence finding the height by Simmonds' Tables for barometrical measurements.

		Inches.
209°·335 gives (by interpolating)		28·375
197·64	„	22·332
28·375	Simmond's Table VI.	—87407
22·332	„	81151
		6256
	„ VII.	1·07
		6693·92
	„ VIII.	0·
	„ IX.	16·7
	„ X.	3
Height		6713·6

Method (*f*), by Tregold's Formula,

$$b = \left(\frac{t + 100}{177}\right)^6$$

t = 209·335		
100		
309·335	log.	2·490429
177	„	2·247973
		·242456
		6
b = 28·493	log.	1·454736

* A collection meeting almost all the requirements of them eteorologist. The tables have been recomputed from the most trustworthy data. To obtain many of them separately would be as expensive as this whole collection. What is perhaps a greater recommendation, the writer has not been able to find a single typographical error. The publisher is Potter, in the Poultry.

Similarly for t = 197°·64, b is found equal to 22·610 inches.

Then by Simmonds' Tables, the height deduced is 6486 feet.

Comparison of Results.

(*a*) = 6720
(*b*) = 6556
(*c*) = 6711
(*d*) = 6751
(*e*) = 6714
(*f*) = 6486

2. Suppose that at
Upper Station, b = 187°·3, air = 26°
Lower „ B = 210·4, „ = 68
Then by method, (*a*) the difference of height deduced is *13086 feet.*

„	(*b*)	*12807*
„	(*c*)	13005
„	(*d*)	13075
„	(*e*)	13020
„	(*f*)	about 12600

3. Suppose that a series of observations made at a station on a tropical mountain, gives a mean boiling-point for water of 185°; and the mean barometer at the nearest observatory in the adjacent country be 29·72, reduced to 32°; what will be the probable difference of height. Temperature at upper station 76°, at lower 84°.

Pressure 29·72 inches = 211°·66 boiling-point.
Whence height = 16110 feet.

4. At the top of Ben Nevis water boils at 203°·8; near the Caledonian Canal at 212°; the temperature of the air above being 30°, and below 35°; find the height.

Height 4350 feet.
Said to be by measurement 4358 feet.

5. The yearly mean of barometer at 32° has been found to be: at Mahabuleshwur 25·684 inches, of the air temperature 66°·6; and at Dodabetta 22·046; and 53°·2 respectively; the mean latitude is 15° N.

The height deduced by Mr. Simmond's barometrical tables is 4261 feet; and by converting the pressures into the corresponding boiling temperatures by Sir H Jame's Table, and computing with Simmonds' Boiling Point Tables, the height is found to be 4270; so close is the accordance between the methods of calculation.

ABRIDGMENTS OF

SPECIFICATIONS OF PATENTS

RELATING TO WATCHES, CLOCKS, AND OTHER TIMEKEEPERS.

(*Continued from page* 109.)

1847, February 11.—No. 11,576.

BRETT, Alfred, and LITTLE, George.—"For improvements in electric telegraphs, and in the arrangements and apparatus to be used therein and therewith, part of which improvements are also applicable to timekeepers and other useful purposes." The invention principally relates to electric telegraphs. The patentees cause the electric fluid to pass through a number of coils of fine wire, properly coated or covered with silk or other suitable non-conducting material, which wire is wound round a flat reel of ivory; the end of these fine wires being alternately brought into contact with the galvanic battery, whereby the current is made to act on and give motion to a partially magnetized ring or piece of metal suspended and moving in a plane parallel to the face of the flat reel. The patentees also use the said rings and reel of wire in the part of the invention relating to clocks.

Two of these partially magnetized ring are fixed to the pendulum rod by means of an oval tube, constructed so as to be moveable up and down the lower end of the pendulum rod for the purpose of adjusting their position. These rings move in a plane parallel with the face of one of the above-mentioned reels of wire and pass one on each side of the reel. The conducting wire of the battery is connected with the reel, which is suitably fixed; and a suitable arrangement must be made for alternately breaking and completing the current of electricity by the motion of the pendulum.

Or the reel may be made to vibrate, and the magnetized rings made to be stationary; in which case the conducting wire from the battery must be brought down the back of the pendulum rod.

[Printed 7*s.* 9*d.* See London Journal (*Newton's*) vol. 30 (*conjoined series*) p. 357; Mechanics' Magazine, vol. 46, p. 20, and vol. 47, p. 185; Artizan, vol. 5, pp. 201 and 275; Patent Journal, vol. 3, pp. 265, 282, 310, 341; and Engineers' and Architects' Journal, vol. 10. p. 294.]

1847, March 23.—No. 11,634.

HATCHER, William Henry, — 1. Combining permanent magnets and voltaic or temporary magnets for giving visible signals for telegraphic purposes.

2. The use of the same arrangement to give signals by means of sounds differing from each other.

3. The use of the same for giving audible signals at the same time that visible ones are exhibited.

4. Refers to "the rheotome, or rheopeter," by which words the patentee designates apparatuses for breaking and completing electric circuits. He uses tubes or vessels of glass or other suitable material containing within them mercury or an amalgam of mercury. These tubes having had the common air expelled are hermetically sealed. Wires of platinum are previously passed through the sides of the tube, and the ends projecting into the interior form the means of connection of the mercury with the other parts of the circuit; the circuit being completed when both ends are touched by the mercury at the same time. These may be applied to pendulums to make and break the circuit.

5. Arranging electro-induction apparatus so as to render the transmission of a current in one or other direction for telegraphic purposes by moving one or other of two communicating mechanisms.

6. Setting the hands of one or more clocks or timekepers so as to indicate the same time as the governing clock by means of electricity. Each of the clocks to be adjusted has a voltaic magnet, the poles of which project through part of the thickness of the dial plate. The minute hands are of steel or iron, and are made so as to slip round on their arbors. When the electric current is transmitted by the governing clock, the voltaic magnets draw the respective minute hands to the proper time. The mode of causing the governing clock to transmit the current which the patentee prefers, is by placing in the wheel which is placed on the arbor carrying the minute hand, a pin so situate, that, a few minutes before the time for setting, it comes in contact with a small spring, and depressing it brings a stud below the springs into contact with the mercury in a small cup, by which action it completes a circuit with a voltaic battery through the primory coil of an induction apparatus, of which the secondary coil has its ends connected with the two ends of the circuit in which the magnets of the series of clocks are, so that any secondary current which might be excited in the induetion apparatus would be transmitted around each of these several magnets, and produce the effects detailed above. At the moment the minute hand points to the time fixed on, the spring is released and the primary circuit broken, and at this moment the secondary current is transmitted to the clocks.

[Printed, 3*s.* 2*d.* See Mechanics' Magazine vol. 47, p. 357; and Patent Journal, vol. 3, pp. 452 and 474.

INTERNATIONAL EXHIBITION, 1862.

To the Editor of the Horological Journal.

Sir,—The relative position in society of trade and profession, depends less on the comparative requirements of intellect involved, than in the honour and refinement of feeling current in the two divisions.

The occasion of the adjudication of prizes at the Exhibition was one of a public character calculated

Rain fell on 20 days, during 83 hours, to the amount of 9·45 inches.

According to the 9 a.m. observations the wind has blown 11 days from N; 1 from E; 4 from S; and 14 from W.

EQUATION OF TIME TABLE

For August, 1862.

Day of the Week.	Day of Month	At Apparent Noon. — Equation of Time to be *added* to Apparent Time.	Difference for One Hour.	At Mean Noon. — Equation of Time to be *subtracted* from Mean Time
		m. s.	s.	m. s.
Fri...	1	6 3·83	0·155	6 3·85
Sat...	2	6 0·10	0·182	6 0·12
Sun...	3	5 55·75	0·208	5 55·77
Mon..	[illegible]	5 50·77	0·233	5 50·79
Tues..	5	5 45·17	0·258	5 45·20
Wed..	6	5 38·97	0·284	5 39·00
Thurs.	7	5 32·16	0·309	5 32·19
Frid..	[illegible]	5 24·75	0·334	5 24·78
Sat...	9	5 16·75	0·358	5 16·78
Sun...	10	5 8·16	0·382	5 8·19
Mon..	11	4 59·00	0·405	4 59·04
Tues..	12	4 49·29	0·428	4 49·32
Wed..	13	4 39·03	0·450	4 39·07
Thurs.	14	4 28·24	0·472	4 28·27
Fri...	15	4 16·91	0·493	4 16·95
Sat....	16	4 5·07	0·514	4 5·10
Sun...	17	3 52·74	0·534	3 52·77
Mon..	18	3 39·92	0·554	3 39·94
Tues..	19	3 26·61	0·574	3 26·64
Wed..	20	3 12·83	0·593	3 12·86
Thurs.	21	2 58·59	0·612	2 58·61
Fri ...	22	2 43·90	[illegible]	2 43·93
Sat....	23	2 28·78	[illegible]	2 28·80
Sun...	24	2 13·23	0·665	2 13·25
Mon..	25	1 57·26	0·682	1 57·27
Tues..	26	1 40·89	0·699	1 40·90
Wed..	27	1 24·11	0·715	1 24·13
Thurs.	28	1 6·95	0·731	1 6·96
Fri ...	29	0 49·42	0·746	0 49·43
Sat...	30	0 31·52	0·760	0 31·53
Sun...	31	0 13·27	0·773	0 13·27

TO CORRESPONDENTS, &c.

All Communications for this Journal should be addressed to the Editor, *at the Office*, 35, Northampton Square, Clerkenwell.

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END OF VOLUME IV.

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